Measuring Meadow to Determine Quantity of Seed
Hollywood Elementary School
St. Mary's County Public Schools

Case Study: Meadows

In the Spring of 1996, Hollywood Elementary School (St. Mary's County) students in first grade through fifth grade were involved in converting approximately 1/4 acre of lawn on the school site to a wildflower meadow. The students in each of the classes participated in various pre- and post-investigations, in addition to planting a section of the meadow. Technical support for the project was provided by Rich Mason of the U.S. Fish and Wildlife Service and Mary Piotrowski, naturalist and school volunteer.

Several pre-planting investigations were part of the meadow project:

- Conducted a Wildlife Habitat Comparison of an existing meadow (old farm field) and a mowed lawn. Using hula hoops to select random sample areas in the meadow and the lawn, the students compared plant diversity, food sources, cover, and evidence of wildlife.
- Compared survival rates of tricolor pasta which represented "camouflaged prey" in the meadow and in the lawn. Students acted as predators and searched for the "prey" in each habitat to draw conclusions about which habitat provided better cover for the "pasta animals," and which color animal was better adapted to each respective habitat.
- Researched the amount of pollution generated by the lawn mowers used to mow the lawn, and how much money would be saved by converting the area to a meadow.
- Observed the sun's movement across the planting area. Students made drawings of the area at times throughout the day to record the amount of sunlight and shade reaching different parts of the area.
- Tested the soil to determine how compacted the soil is and how well it drains.
- Used trundel wheels to measure the planting site. Students then calculated the area of the site.
- Calculated the amount of seed needed. Approximately 5 lbs of seed was used per acre.
- Compared the composition of the two seed mixes used. Students used a Venn diagram to show which seeds were common to both mixes and which seeds were present in only one of the mixes.
- Researched what kinds of birds, butterflies, and other animals will be attracted to the plants listed in the seed mixes.

Raking Soil in Preparation for Hand Broadcasting Seed
Hollywood Elementary School
St. Mary's County Public Schools

Two different seed mixes were used. The U.S. Fish and Wildlife Service provided one mix and the P.T.A. purchased a different variety. One mix was planted in one half of the planting area and the other mix in the other half. After two years, there does not appear to be a significant difference between the two mixes. Some of the seed mix was reserved to plant in bare spots the following Fall. The seed mixes were still viable after one to two years of storage in the refrigerator. To make it easier for the children to broadcast the seed, seed was mixed with sand. The sand acted as a carrier, making it possible to spread the seed more evenly. In addition, because the sand was a different color than the soil, the children were able to see where they had spread the seed.

After eradicating the existing lawn, a local farmer tilled the area with a tractor. The area was divided into eight sections. Students in two classrooms were responsible for one section. The students began raking to loosen the soil. The sections that had been raked more had better success.

Naturalist Mary Piotrowski worked with each of the classes as they planted. The students used the following procedure:

- Rake the soil.
- Practice broadcasting sand without seed in a non-planting area.
- Broadcast the seed ("Feed the chickens").
- Rake the seed into the soil.
- Stomp the area with your feet (Do the "Meadow March").
- Spread straw over the area.
- Water with a sprinkler.

Several post-planting investigations were conducted:

- Writing letters to another school to explain the benefits of planting a meadow and the method used.
- Monitoring the growth of the meadow.
- Keeping a log of the wildlife that visits and inhabits the meadow.
- Putting socks over the students' shoes to collect and observe seeds.
- Making observational drawings of the wildflowers and using field guides to identify them.

The meadow requires very little maintenance. The meadow is mowed once a year in the Fall to disperse the seeds and to maintain it as a meadow.

The school staff is very pleased with the success of the Meadow Planting Project. The project continues to benefit the students each year by enabling them to experience and interact with the meadow firsthand, and understand the importance of the meadow ecosystems and its connectedness to other ecosystems. Converting an area of unused lawn to meadow has increased its habitat value for wildlife and its educational value for the students.

Environmental Enhancement

A meadow is a grassland with a mixture of wildflowers and native grasses. In the eastern United States where moisture is abundant, meadows are usually temporary and, if left alone, will succeed into a woodland. Historically, there were more meadows in the East than there are today as fires set by lightening and Native Americans kept trees out of certain areas and allowed meadows to thrive. Grazing by animals that once existed in the East, including elk and bison, also helped perpetuate Eastern grasslands.

Meadows provide a unique habitat for a variety of plants and animals. Native grasses form the primary structure of meadows. Unlike the turf forming nature of lawn grasses, many of the native grasses grow in bunches. The bunch forming habit creates nesting spaces and travel corridors for a variety of birds including bobwhite quail, bobolinks, meadowlarks, ground nesting sparrows and many other birds. Rabbits, voles and other small animals take advantage of this bunch-like structure. The wildflower or forb component of meadows provide additional structure but more importantly provide nectar and seeds for birds, mammals and many insects. Insects are vitally important as they are at the base of the Earth's food web and provide the free service of pollination. A variety of fascinating butterflies abound in meadows. Predators including hawks and foxes are attracted to the abundance of prey species in meadows.

Meadows, like forests and wetlands, provide protection to streams and, ultimately, the Chesapeake Bay as the thick vegetation allows rainwater to slowly percolate into the ground filtering out pollution. Recharged groundwater delivers cool, clean water to streams.

Restoring grasslands is a high priority to biologists as the acreage of this habitat has dwindled to a critical level. Only one percent of the original prairie remains of the huge grassland that once stretched from the Ohio Valley to the Rocky Mountains. Acreage of Eastern grasslands are also at an all time low.

Contribution to Educational Programs

Once a meadow is established there are many hands-on instructional activities that can be developed. A meadow is a rich resource for students. Younger students can use the meadow to visualize and describe colors, shapes, textures, and smells. Children can learn to write, spell, and read words and sentences related to the meadow. Leaves, flower petals, seeds, and insects can be used to teach introductory mathematics. Older students can keep a journal about the meadow through the entire year making observations and entries once a week. From their journal entries, students can develop an information fact sheet about the meadow, complete a creative writing task or develop a play or skit about some aspect of the meadow. World geography can be learned by mapping grassland habitats around the world. A wealth of science investigations that also incorporate mathematics and language arts can be taught using the meadow. Habitats, birds, plants, insects, pollination, soil, water cycle, and photosynthesis, are just a few of the many science topics that can be taught using a meadow.

Planning, Design, and Construction

Most areas on a school site not designated for a specific use are typically seeded in turf-grass. These areas are excellent candidates for meadow establishment. Meadows can be planted over septic drainfields as a low maintenance option to turf. An ideal place to establish a meadow is on embankments including those within stormwater management ponds. The National Resource Conservation Service has seed mixes for embankments (See Table 3).

Seedmixes for Dams/Spillways and Embankments Table 3 (Natural Resource Conservation Service)

On existing school sites, proper ground preparation is critical for desired results. Turf-grass and weeds are very aggressive and should be removed.

The size of the meadow is related to available space. A meadow can range from a 100 sq. ft. meadow garden to several acres. A large meadow will provide many more environmental benefits than a smaller one. When designing the shape of the meadow, plan for gentle curves as opposed to straight lines. Mowed trails should be an integral part of larger meadows.

A commonly asked questions is, "Can we let the lawn grass grow to establish a meadow." The answer is yes; however, turf grasses and weeds that make up school lawns will not develop into a colorful and interesting meadow of native plants. If the area is to be managed as a meadow, then it is best to remove existing turf and weeds, and plant meadow seeds or plants. However, if the long term plan is to allow the area to evolve into a woodland then the lawn grass can be left to grow. Grasses and weeds will eventually give way to colonizing tree seedlings as a young forest develops.

Site Selection

A meadow can be planted almost anywhere that has at least 6 hours of sunlight during the growing season. If plants (including grass) are already growing on the potential site, it is likely the soil is suitable for meadow establishment. Be aware that tall meadow grasses can block the vision of motorists near intersections and bus travel lanes.

After the site is selected, gather information about the growing conditions that include sunlight, soil texture, and soil moisture. This information will allow selection of an appropriate species mix.

Sunlight - A minimum of 6 hours of sunlight is needed for meadow plants.

Soil Texture - Determine if the soil texture is *clayey*, *sandy* or an intermediate soil texture called *loam*.

Moisture - Decide if the site is wet (puddles remain for several days or weeks after hard rains), very well drained (puddles do not form after rain) or moderately well drained (average soil drainage). Soil moisture in most situations is directly related to the soil texture. For example, clay soils are generally wetter since they drain slowly and sandy soils are generally dry since they drain quickly.

Note: To have your soil professionally evaluated, bring a sample to your local Soil Conservation District Office or send a sample to the Cooperative Extension Service (see Appendix B).

Plant Selection

It is important to select species that are adapted to the soil and moisture conditions of the site. Locally native plant species should be used as these are best adapted to local climate and soil conditions. Be cautious of mixes in seed catalogs called "Northeast or Southeast Mix" as these usually only contain a few plants native to the region. Students can research and develop their own mix using seed catalogs or site information can be given to a seed supplier to develop a mix.

A good mix contains 50% perennial wildflowers and 50% native grasses. A cover crop of oats and barley at 20-40 lbs/acre should be used on sites with exposed soil to prevent erosion. A cover crop is not needed in no-till applications (see discussion of mechanical seed drill method on page 39). Most perennial wildflowers will take 2-3 growing seasons before blooming. Seeds planted in the spring will begin to bloom the following spring or later. Patience is important.

For sites less than 1,000 sq. ft. plants are often used although seeds can be used. Plants will give quicker results. For larger sites, seeds should be used. For larger seeded sites, the seeded area can be supplemented with plants. Plants will provide blooms the first growing season.

Recommended seeding rates vary widely from between 6 and 15 pounds per acre. When ordering seeds, inquire about the optimum rate for your site. If using plants, space on 2´ centers.

Ground Preparation and Seeding Method

Hand broadcasting seed and using a mechanical seed drill are the two seeding methods outlined. Several ground preparation approaches are provided depending on the size of the project. Select the ground preparation option that best fits the needs of the project and be diligent about completing the recommended steps. The best success is achieved with thorough ground preparation.

Planting a meadow on a new construction site is less difficult than an existing site where turf must be removed. There are a few basic tips to follow for newly graded sites. Topsoil should be saved and spread across the site. Do not use fertilizer as meadow plants are adapted to low fertility soils and fertilizers promote weed growth. Do not use lime as this also encourages weeds. Use the hand broadcast or mechanical seed drill method (see following discussion). When hand broadcasting, roll the site after seeding to ensure good seed to soil contact. When using the mechanical seed drill, firmly pack the seed bed before seeding. Hydro-seeding is not recommended as results have not been satisfactory. At

the same time the meadow is planted, spread 20-40 lbs/ acre of oats or barley seed for quick cover to stabilize the soil. Finally, lightly cover the site with a clean straw mulch.

On existing school sites, turf must be diligently removed before seeding is done. Several methods are explored in the following discussion.

The seeding recommendations that follow recognize that wildflower seeds germinate better when planted in the fall and that grass seeds germinate better when planted in the spring.

Hand Broadcasting - Hand broadcasting seed is feasible on sites up to an acre. Depending on the size of the meadow, equipment needed for ground preparation varies from shovels and rakes to a disc pulled behind a tractor. More ground preparation steps are involved with this method compared to using a mechanical seed drill. An option for larger areas is to divide the site into smaller sections and complete one section each year by hand broadcasting. The benefit to this approach is that many students can be involved over time. Students can collect seeds from established sections to plant the next section.

GROUND PREPARATION FOR HAND BROADCASTING SMALL SITES WITH EXISTING TURF:

OPTION 1:

June - August
Remove the sod by using a sod cutting machine. Be sure to remove all the roots of the grass. A sod cutting machine can be rented from a tool rental store. Next, lightly till or rake the soil. Water the soil to stimulate the germination of dormant weed seeds. Wait for two weeks of warm weather to allow dormant weeds to germinate. Roto-till or disc the site one to three times waiting two to three weeks between each tilling.

October - November
Plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting (page 39).

April
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

OPTION 2:

March - May
Remove the sod and cover the site with black plastic. Cover with mulch to hold the plastic in place. This process should kill any remaining weeds or grass.

October - November
Remove the plastic. Plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting.

April
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

GROUND PREPARATION FOR LARGE SITES WITH EXISTING TURF:

April - September
Remove the sod with donated or rented equipment. Roto-till or disc the site several times waiting 2-3 weeks between each tilling. Each time more grass and weeds will be removed.

October - November
If the seed bed appears to be mostly weed free two weeks after the last tilling, plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting.

April - May
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

Sample Meadow Mixes for the Mid-Atlantic

The following are three mixes containing species native to Maryland that are available from seed suppliers. The mixes give a range of bloom colors that will be present from late May to October. The lists are provided as a general guideline. Most seed suppliers have ecologists that can be very helpful in developing seed mixes to meet specific needs.

DRY SOIL (mostly sandy to loamy)

FLOWERS	GRASSES
Butterfly Milkweed (Asclepias tuberosa)	Little Bluestem (Schizachyrium Scoparium)
Common Milkweed (Asclepias syriaca)	Indiangrass (Sorghastrum nutans)
Heath Aster (Aster ericoides)	Canada Wild Rye (Elymus canadensis)
Partridge Pea (Cassia fasiculata)	
Showy Tick Trefoil (Desmodium canadense)	
Purple Coneflower (Echinacea purpurea)	
Wild Blue Lupine (Lupinnis perennis)	
Wild Bergamot (Monarda fistulosa)	
Black-Eyed-Susan (Rudbeckia hirta)	
Gray Goldenrod (Solidago nemoralis)	

MEDIUM SOIL (loam to silty clay loam)

FLOWERS	GRASSES
Butterfly Milkweed (Asclepias tuberosa)	Little Bluestem (Schizachyrium Scoparium)
Common Milkweed (Asclepias syriaca)	Canada Wild Rye (Elymus canadensis)
New England Aster (Aster novae-angliae)	Indiangrass (Sorghastrum nutans)
Zig-Zag Aster (Aster prenanthoides)	
Flat-Toped White Aster (Aster umbellatus)	
Showy Tick Trefoil (Desmodium canadense)	
Purple Coneflower (Echinacea purpurea)	
Wild Blue Lupine (Lupinnis perennis)	
Wild Bergamot (Monarda fistulosa)	
Black-Eyed-Susan (Rudbeckia hirta)	
Stiff Goldenrod (Solidago rigida)	
Hoary Vervain (Verbena stricta)	

WET SOIL (typically high clay content)

FLOWERS	GRASSES
Swamp Milkweed (Asclepias incarnata)	Big Bluestem (Andropogon gerardii)
New York Aser (Aster novi-belgii)	Eastern Gama Grass (Tripsacum dactyloides)
Nodding Bur Marigold (Bidens cernua)	Switchgrass (Panicum vergatum)
Joe-Pye Weed (Eupatorium fisulosum)	Fox Sedge (Carex vulpinoidea)
Spotted Joe-Pye Weed (Eupatorium maculatum)	Soft Rush (Juncus effusus)
Boneset (Eupatorium perfoliatum)	Sensitive Fern (Onoclea sensibilis)
Rough-Leaved Goldenrod (Solidago patula)	
Blue Bervain (Verbena hastata)	
Ironweed (Vernonia fasciculata)	

Table 4

STEPS FOR HAND BROADCASTING SEED:

1. To ensure even distribution of seed, mix seed with 3-5 parts moist sand, sawdust or peat moss medium. Moisten the medium to allow the seed to stick.

2. To ensure good coverage, use 1/2 the mix and spread evenly in one direction then spread the other half walking perpendicular to the first pass.

3. Lightly rake or drag a piece of chain link fence across the soil to ensure good soil to seed contact.

4. Compress the soil to ensure soil to seed contact by rolling, having children stomp throughout the entire site, or drive over site with a vehicle.

5. Seed germination is increased if straw mulch is lightly spread across the site. The straw keeps soil moist allowing for better seed germination.

6. The options above recommend planting in the fall and early spring. If planting in late spring or early summer, watering can enhance germination.

Combination Mechanical Seed Drill/Hand Broadcasting Methods - Establishing a meadow using a mechanical seed drill is a simple and effective method. The mechanical seed drill method is generally used only on large sites since the drill is pulled behind a tractor. Special mechanical seed drills must be used due to the fluffy nature of the native grass seeds. Several drills (referred to as Truax or warm season grass drills) are available for loan through the Maryland Department of Natural Resources, Soil Conservation Service or National Wildlife Refuges. Some landscape contractors have the special drill and can be hired to prepare the ground and plant the meadow. If assistance is planned from volunteers such as a local farmer, an experienced person from a natural resource agency or contractor should be on hand to supervise the seeding. If a local farmer agrees to help, make sure the hydraulic connection is compatible between the tractor and drill.

If a mechanical seed drill is used, some seeding should be reserved for students to plant using hand broadcasting. This allows students to be involved in the planting.

GROUND PREPARATION:

April - September
Roto-till or disc the site several times waiting two to three weeks between each tilling. Each time more grass and weeds will be removed.

October - November
Roll the site to create a firm seed bed then plant 1/2 of the wildflower seed with students using the hand broadcasting method.

April - May
Using the mechanical seed drill, plant the remainder of wildflower and all of the grass seed.

Long Term Maintenance

A yearly maintenance plan needs to be developed with the grounds supervisor. A mower or bush-hog that can adjust to a height of 6'' - 8'' is needed for proper maintenance.

The first year requires special attention to reduce weeds. Remove weeds by hand on small sites. For large sites, mow to a height of 6'' - 8'' every six weeks. Mowing eliminates annual weeds before going to seed and will not harm new wildflower seedlings and native grasses. If weeds are not evident, mowing is not necessary.

Beyond the first year, annual mowing is needed. Divide the meadow into two or three sections. Mow one section each year on a rotation before April 1st or after August 31st to avoid the nesting season of small mammals and ground nesting birds. An optional mowing schedule to allow the most cover for wildlife is to mow 1/3 of the site every March. Mowing only a section each year allows cover for wildlife to remain at all times. Butterfly and other insect larvae will survive in the uncut portion. For cutting small sites, a weed whacker or scythe can be used.

After mowing, remove cut material and thatch to sustain the meadow. This practice opens the soil to light promoting the growth of new meadow plants. Removing thatch can be done with a hand rake on small sites or a mechanical rake pulled behind a tractor on large sites. A second method to remove thatch is a controlled burn. Fire is used by grassland managers as a very effective

method to remove thatch, remove woody species, and promote new growth. In the Midwest, where prairie restoration has been underway since 1970, burning is an accepted and necessary management practice even on school grounds. Strict precautions are necessary if burning is done on school grounds. Contact your local fire department or a specialist from the Maryland Department of Natural Resources to oversee a controlled burn.

Cost

In addition to the environmental benefits, there is a significant economic incentive to transforming unused turf areas into meadow. Once a meadow is established, mowing is done once a year for a portion of the meadow as opposed to 12-15 times a year for an entire lawn. Along roadsides, through power line right-of-ways and on corporate commons, meadows are established to significantly reduce maintenance costs while providing an excellent environmental benefit. School systems can also benefit from this landscape practice.

The seed cost for a meadow can range from $400 - $1,200 an acre depending on seed source, seed quantity, and species mix. Seed companies can tailor a mix to your budget.

Student Participation

There are many opportunities for students to be part of the planning, design, and planting of a meadow. Their involvement depends on the method that is used to establish the meadow. At the very least students can:

- Measure, plot, map, and calculate the size of the meadow.
- Determine how many pounds of seeds are needed based on the area.
- Determine if the soil is sandy, loamy or clay, how moist the site is, and use this information to research and select species from a seed catalog.
- Contact community members for assistance with tilling, seed drills, etc.
- Apply for a grant.
- Hand broadcast the seed.
- Monitor seed germination.

Safety

Ticks are a concern with tall grasses. Students should not wade through the meadow. Mowed trails should be used for access. Students should check for ticks each time the meadow is used and parents should be aware of the possibility that their children may pick up ticks.

BEFORE: *Meadow Development*
Seven Oaks Elementary School
Baltimore County Public Schools

AFTER: *Completed Meadow*
Seven Oaks Elementary School
Baltimore County Public Schools

BEFORE: *Wetland Development*
Bohemia Manor Middle School
Cecil County Public Schools

AFTER: *Completed Wetland*
Bohemia Manor Middle School
Cecil County Public Schools

Case Study: Wetlands

A wetland project at Bohemia Manor Middle School in Cecil County was developed from the vision of the 6th grade teaching team. In September 1997, three members of the team attended a workshop given by Environmental Concern, Inc. in St. Michaels, Maryland where they learned how to select and propagate plants for wetlands. With the encouragement and assistance of Rich Mason of the U.S. Fish and Wildlife Service and Laurissa Heller from the Chesapeake Bay Trust they began to plan. A site behind the middle school was selected.

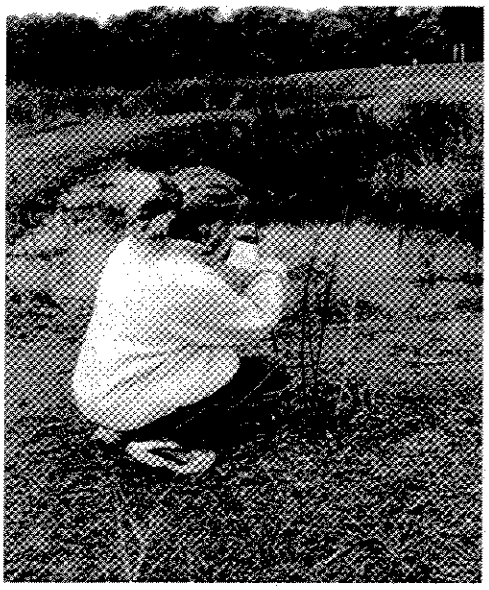
In early January, 1998 one of the team members attended a grant writing workshop. Charlie Hayes and Bill Metcalf of the Cecil Soil Conservation District offered their assistance. The first planning meeting was held in late January, 1998. The Cecil Soil Conservation District agreed to prepare a plan including wetland planting zones, and an observation platform. During the winter months, the team discussed what lessons could be taught using the wetlands as the vehicle.

In math, students drew maps of the proposed wetland and calculated the area of the wetland. In reading, magazines called *Wetlands* were ordered from Kids Discovery. Students read, made bumper stickers, video tapes, and became very knowledgeable about wetlands and their importance to the environment.

With their new knowledge, the science students selected the plants for each wetland zone, and math classes computed the number of plants for each zone and calculated the total cost.

Social studies classes mapped wetlands all over the world and learned the economic and geographical implications and importance of wetlands. In English class, students used what they learned to write a grant to the Chesapeake Bay Trust and letters to local businesses requesting contributions.

Excavation of the wetland began during spring break. When the students returned to school, the wetland was holding water. There were many community people and businesses involved in providing funding,



Labeling Plants
Bohemia Manor Middle School
Cecil County Public Schools

equipment, materials, and labor. A grant for about $900.00 was received from the Chesapeake Bay Trust and used to order plants. A small portion of the grant money was spent for two substitute teachers and on May 19, 1998, 153 6th grade students planted plants in shifts. Rich Mason gave students instruction and was there to answer questions. Local community supporters were there all day.

The wetlands project was a great success. The project helped the environment, taught students and teachers a great deal about wetlands, and joined together the community for a common goal. As educators, the 6th grade team made strides in interdisciplinary education.

The 6th Grade teaching Team at Bohemia Manor Middle School were:

Beth Kirk - Science
Carla Webb - English
Sandy Grimes - Math
Colette McCollum - Reading
Ted Gorzkowski - Social Studies

Environmental Enhancement

A school wetland is an aquatic laboratory that provides students with hands-on instructional opportunities in all school subjects. Wetlands add interest to the schoolgrounds while providing a source of endless discovery for students.

In addition to being an excellent educational resource, wetlands are a critical habitat for plants and animals. Non-tidal wetlands provide a buffer to streams as they filter, trap and biologically or chemically break down pollutants that run off developed lands and agricultural fields. Wetlands act like a sponge, helping to minimize flooding. Certain wetlands are important for groundwater recharge. Tidal wetlands are especially important as a nursery ground for many fish and shellfish.

Despite all the benefits, wetlands are still being destroyed nationwide at an alarming rate. Over the last 200 years, half of the wetlands in the United States have been eliminated (approximately 100 million acres of wetlands). Citizens, government agencies, and private organizations now realize the importance of wetlands. Since the 1980's a major initiative has been undertaken to restore some of the lost wetland acreage. By preserving and constructing wetlands on school sites, we can help the school community better understand wetlands and be an integral part of this national effort.

There are many different types of wetlands and they are classified by the dominant vegetation type and/or hydrology. An emergent marsh is the most popular type of wetland built on school sites. An emergent marsh is a pond that is shallow enough for plants to emerge from the water surface. Typically, marshes are less then 3' deep. Marshes are dominated by herbaceous plants, such as cattails, with shrubs and small trees on the edges of the flooded portion. In contrast to a marsh, a pond is deeper, and therefore, is primarily open water without plants. For safety reasons alone, a wetland is far superior to a pond in a school setting. Other types of wetlands include forested wetlands, scrub shrub wetlands, wet meadows, bogs, and fens. Depending on site

conditions, there may be an opportunity to construct several wetland types on school grounds. Further discussion in this chapter focuses on designing and constructing an emergent marsh wetland.

Planning, Design, and Construction

New Construction and Renovation Projects

An ideal time to incorporate a wetland feature is during the planning of a new building or renovation project. In many cases the requirements for stormwater management can be met by designing a stormwater wetland as opposed to a dry or wet pond. Small pocket wetlands or rain gardens (see page 22) incorporated throughout the site will provide credit to stormwater calculations and can help significantly reduce the size requirements and cost of stormwater management. When engineering the site hydrology, consider using some or all of the water from roofs, parking lots, and fields to create one or many small wetlands. For example, many schools are built with a bus loop island of grass with curb and gutter. To make better use of the bus loop island, design it as a slight depression instead of higher ground. Channel runoff from the driveway and/ or the roof to the island and create a broad shallow marsh. Do not be concerned if the wetland does not hold water year round. Temporary or vernal pools provide vital amphibian breeding habitat and can be planted with an interesting diversity of plants.

Existing Schools

Many existing school sites are conducive to creating or even restoring wetlands. In order to determine if it is feasible to construct a wetland, begin by examining rainwater runoff. Each site is different and has different opportunities and limitations.

Selecting the proper site is the key to a successful wetland project. The four basic considerations are listed below. In addition, be careful not to alter an existing natural area to construct a wetland. Streams should not be diverted or dammed nor should a woodland be cleared to construct a wetland. Naturally occurring wetlands should never be altered while degraded wetlands can be restored.

Hydrology - There needs to be sufficient water feeding the wetland site. It is best to rely on surface runoff to supply the wetland versus groundwater which is usually not reliable due to fluctuations between seasons and from year to year. The volume of runoff will dictate the size of the wetland. See information below on determining runoff volume.

The following bullets address different school site features related to water sources for creating wetlands and offer ideas on how each feature can be used or manipulated for a wetland project.

- Rain water from rooftops and parking lots: These are two reliable sources of water. With rainfall, water runs off and eventually makes its way to a nearby stream. The premise is to intercept some or all of the water by building a shallow depression, a wetland, to hold the water. Channeling water from roofs or from paved surfaces with a curb cut are simple ways to divert rainwater.

- Ditches or swales: Options include plugging or partially plugging a ditch with soil in order to back up water and create a shallow flooded area. This can be done in conjunction with shallow excavation. The sides of a ditch or swale can be pulled back to create a shallow pool. A third option includes diverting water from a ditch with a pipe or open channel to the desired spot and excavating a shallow depression.

- A spring or seep: A spring in an existing woodland or wetland should not be disturbed because these areas often harbor unique or rare plants and animals. If a spring exists that is already disturbed (the side of a mowed hill or field) then capturing the water to build a wetland should not be a problem.

- Wet and muddy areas: For one reason or another certain areas on school grounds remain wet and muddy. If these areas are not jurisdictional wetlands and are not an existing natural area, a shallow excavation can create a vernal (temporary) wetland or, possibly, a perennial (permanent) wetland.

- Storm drains or grates: Grates in fields can be raised or a low earth berm constructed around drains to back up water. Be aware that sand or gravel may have been placed around the concrete riser that supports the grate. If this is the case, several inches of clay soil should be packed on top of the sand and gravel to prevent seepage around the riser. The berm should be constructed of heavy soil to minimize seepage.

- Pipes carrying stormwater: In certain cases, underground pipes carrying stormwater can be tapped diverting the water as a source for a wetland.

- Stormwater management basins: Excavate shallow depressions in dry stormwater basins to intercept and hold water to create small wetland pools. This should not alter the storage capacity of the structure. Excavated soil may need to be hauled off site. In certain cases, wet ponds can be planted with a marsh fringe and an upland buffer. Trees and shrubs should not be planted on the dam side of the structure. Their root system can damage the dam and allow water to penetrate. Work with design engineers for modifications of stormwater basins.

Slope of Ground - The more level the area the less earth movement required. If the area has a gentle slope, construct a series of shallow, narrow pools stepping down the slope. Steeper slopes are more difficult to work with.

Soil - The higher the silt/clay content of the soil the better. Soils with a silt/clay content over 21% drain slowly and are ideal for ponding water, thereby creating a wetland. A representative from the county Soil Conservation Service can determine if the soil is suitable for constructing a wetland. If the site has well drained soils, a layer of clay can be used as a liner to hold water. **Note:** The entire soil profile does not need to have poorly drained soils to construct a wetland. For example, if at a depth of two feet there is a 3" layer of silty clay then this should be sufficient to slow seepage and create a wetland. Be sure not to dig through this layer during excavation.

Vegetation - Students and school staff should be responsible for designing the wetland planting and installing the plants. Student planting plans can be reviewed and edited by a wetland specialist.

Wetland Design

While a wetland can vary from simple to complex, wetland specialists should be consulted for design and construction. Students can contribute concept designs. Certain secondary school classes may be able to complete a design and construct the project with guidance. While the concept of a wetland is simple, success is achieved by giving attention to details of design, construction, and maintenance.

Size - Building the largest wetland possible, given the limitations of the site, is a reasonable goal. Too often schools build a small wetland in areas where a larger project was possible. A larger wetland will allow a more diverse plant and animal community to become established and provide students more opportunities for investigation and discovery. Also, the impact to plants and animals from student use will be less if it is spread over a larger area. Creating several smaller wetland pockets with upland in between is a good option to creating a larger wetland.

Calculating runoff volume is not necessary on small wetlands. If you are unsure about the amount of water or the wetland is large, it may be necessary to calculate runoff volume. Refer to the USDA manual titled *Ponds-Planning, Design, Construction* (local Soil Conservation offices should have a copy). The ideal site has an ample supply of water so that the wetland remains at least saturated throughout the year. However, vernal or seasonal wetlands are an excellent option for drier sites. These wetlands remain wet through the winter and spring and dry out during the summer. Many wetland plants are adapted to this fluctuating water regime. Several species of animals, including many amphibians, are native to vernal pools. The lack of fish predators that eat tadpoles are the main reason many amphibian species seek vernal pools.

Shape - An irregular shape is best as it creates a more natural look. An irregular shape will make more nooks and crannies which provide a better habitat and make the wetland more interesting for exploration.

Depth and Micro-Topography - An optimal design includes broad shallow areas 0-6'' deep interspersed with pockets varying from 12-24'' deep. Slopes between shallow and deeper pools should be gradual for safety. This design allows emergent wetland vegetation to colonize most of the site with the deeper pockets remaining open. Deeper pools serve as a refuge for amphibians during droughts and also provide habitat for fish. Based on feedback from principals and teachers who have completed wetlands, an open water component is desirable especially from an aesthetic standpoint. If deeper pools cannot be added due to soil limitations or safety reasons, an open water feature can be accomplished by placing large flat rocks along the bottom in a few locations to deter plant growth.

Micro-topography refers to a rough uneven wetland bottom with subtle humocks (islands) and pools. This will allow for the greatest diversity of plant and animal growth.

Slopes - For easy access and safety, the upland area leading down to the wetland and the bottom contour of the wetland should be gradually sloped. A slope of about 5:1 or less is desirable.

Liners - If the soil in the proposed wetland area is well drained, fine textured (>20% clay) soil can be used to line the site and create poorly drained soils. Clay is a much better option then using a rubber liner. Unlike rubber, clay will not puncture or degrade. The use of clay is usually less expensive and it creates a more natural wetland.

Stabilizing Slopes - Slopes and disturbed areas need to be stabilized immediately. Typically, a mix of k-31 fescue and other non-native grasses are used to stabilize soil. While these mixes provide soil stabilization, they provide little habitat and k-31 fescue is an invasive plant. The Natural Resource Conservation Service has developed approved alternative mixes that are native and provide better habitat while stabilizing soil. These include:

- Dams and spillways: 25 lbs/acre each of creeping red fescue, hard fescue, and sheep fescue. Add 5 lbs/acre common white clover.

- Cut slopes or flat ground adjacent to wetland: 20-40 lbs/acre of oats or barley for quick soil stabilization. Add warm season grass/wildflower mix at 10 lbs/acre. A typical mix includes:

Grasses

Little bluestem *Schizachyrium scoparium*
Indiangrass *Sorgastrum nutans*
Switchgrass *Panicum vergatum*

Wildflower (add several of the following; many others are available)

Black-eyed susan *Rudbeckia hirta*
Beebalm *Monarda didyma*
Butterfly milkweed *Asclepias tuberosa*
Common milkweed *Asclepias syriaca*
Goldenrod *Solidago sp.*
Heath aster *Aster pilosus*
Lance leaved coreopsis *Coreopsis lanceolata*
New York aster *Aster novae-belgii*
New England aster *Aster novi-angliae*
Purple coneflower *Echinacea purpurea*
Wild bergamot *Monarda fistulosa*
Wild columbine *Aquilegia canadensis*
Wild blue indigo *Baptisia australis*

Legumes

American vetch *Vicia americana*
Bush clover *Lespedeza capitata*

Other Features - Partially submerged logs provide hiding and a basking spot for turtles and frogs. A wooden walkway or dock can be constructed on the edge or through the wetland. An enclosed wildlife observation blind can be built on the edge of the wetland.

Wetland Construction

Conserving Topsoil - Remove the topsoil and set this aside. Complete the excavation, install the liner material, if necessary, then spread the topsoil layer across the bottom of the wetland. Plants will grow much better in topsoil. Topsoil has important organic matter that provides the fuel for plants and the small organisms at the base of the food chain. Organic matter (e.g., mulch, straw) may be added to the wetland bottom and backslopes. Prior to excavation, it may be necessary to roto-till or disc the sod if it is a dense mat.

Topography - Most equipment operators take pride in building smooth even pond bottoms. Be sure to convey to the contractor that the bottom is to be rough and uneven.

Erosion Control - Erosion control fabric should be used in spillways or swales where moving water could erode soils. Mats of sod can be scraped off the excavation site, then used in place of erosion control fabric. Wetland vegetation should be planted for long term erosion control.

Liners - If a clay liner is used, the clay should be kept moist for easy spreading and not allowed to dry out after construction. Use three to five inches of clay. Six to eight inches of topsoil or loamy soil should be spread on top of the clay. This will provide a good substrate for the roots of the wetland plants. Adjust the depth of excavation to allow for the clay liner and soil on top of the liner. If a rubber liner is used, eight to ten inches of soil should be placed on top of the liner. Wetland plants can then be planted directly into the soil. Soil is an integral part of a wetland system.

Wetland Buffer - Two general types of buffers can be planted around a wetland. The first is a buffer of trees and shrubs. The second is a grassland/wildflower meadow buffer. If a grassland buffer is planted, a few shrubs should be planted on the wetland edge, as these will provide important habitat for birds and amphibians. The buffer should be a minimum width of 25 feet and wider if space allows.

Planting Plan - It is suggested that students complete this exercise, then have their plant list reviewed by a natural resource specialist. Order nursery catalogs from wholesale wetland nurseries for students to use. Select plants native to your site and select wild varieties over cultivars.

Table 5 lists plants by moisture zones native to Maryland and widely available through nurseries. This is not a comprehensive list.

ZONE 1 Upland

shrubs
Sweet Pepperbush (Clethra alnifolia)
Spicebush (Lindera benzoin)
Highbush Blueberry (Vaccinium Corymbosum)
Arrowwood (Viburnum dentatum)

trees
Shadbush (Amelanchier canadensis)
River Birch (Betula nigra)
Hackberry (Celtis occidentalis)
Persimmon (Diospyros virginiana)
Tulip Poplar (Liriodendron tulipifera)
Willow Oak (Quercus phellos)

ZONE 2 Wetland Edge

shrubs
Smooth Alder (Alnus serrulata)
Buttonbush (Cephalanthus occidnetalis)
Silky Dogwood (Cornus amomum)
Red-osier Dogwood (Cornus stolonifera)
Winterberry (Ilex verticillata)
Elderberry (Sambucus canadensis)

herbaceous plants
Swamp Milkweed (Asclepias incarnata)
New England Aster (Aster novae-angliae)
Joe Pye Weed (Eupatorium dubium)
Soft Rush (Juncus effusus)
Cardinal Flower (Lobelia cardinalis)
Switchgrass (Panicum virgatum)
Woolgrass (Scirpus pungens)
New York Ironweed (Vernonia noveboracensis)

ZONE 3 Shallow Wetland 0-6''
Sweet Flag (Acorus calamus)
Tussock Sedge (Carex stricta)
Rose Mallow (Hibiscus moscheutos)
Blue Flag (Iris versicolor)
Three Square (Scirpus pungens)
Eastern Bur-reed (Sparganium americanum)

ZONE 4 Deep Wetland 6-12''
Pickerelweed (Ponederia cordata)
Duck Potato (Sagittaria latifolia)
Lizards Tail (Saurrus cernuus)
Soft Stem Bulrush (Scirpus tabernaemontani)

Sample Native Plants for Moisture Zones within a Wetland Table 5

Long Term Maintenance

Monitoring and observing changes over time is the key to making management decisions. It is very helpful to work with a wetland specialist or botanist to provide guidance. The following are some general maintenance guidelines.

- Removing invasive exotic species: Phragmites and purple loosestrife are the two non-native species of concern, although there are others. Cattails, while native, can be very aggressive and should be monitored carefully. Cattails are well adapted to grow in disturbed areas such as stormwater management ponds. In these areas it may be an uphill battle to control cattails as they will return each year. It may be best to let the marsh develop as a cattail marsh.

- Colonization by other plants: Other plants will colonize the site. This is a natural process that will add to the diversity of your habitat. Some may compete with your plants. If the colonizing plants are not invasive, it is best to leave them alone.

- Adding more plants: Some wetland plants spread rapidly; therefore, it may not be necessary to add plants. If you need to add plants, wait until late in the spring after dormant plants have come up to avoid crushing the dormant plants.

- Watering: Upland plants need to be watered for at least the first summer after planting.

- Coordination with maintenance staff: It is essential to let the maintenance staff know where to mow and where not to mow. Un-mowed areas should be marked with stakes or a diagram. One of the single biggest frustrations associated with school habitat projects is new plantings being damaged or killed by mowing.

- Water fluctuation: Many plants adapt to natural fluctuations in water levels. However, if the water either floods too deep or too often, or dries out too much then certain plants may not survive. Therefore, it is important to keep track of which species survive. More often then not, too much water is the cause of plants not surviving. There are other reasons for plants dying such as poor planting technique, poor nursery stock, or disease but water levels play a major role in plant survival.

- Erosion: Watch closely for rills that may develop from moving water especially if a low berm or dam was constructed and overflow water moves through an established swale. Mats of sod can be used to stop erosion in swales. Willow stakes can be used to combat erosion. A low check dam(s) can be constructed to control flow, reduce erosion, and dissipate energy in swales. As a last resort, the swale can be lined with rock.

- Siltation: Through siltation, the depth of the wetland will reduce over time. This is a natural process. Reducing erosion in the drainage area will slow down this process. A decision should be made if and when to remove silt or to let the natural process continue.

- Adding animal species: One of the most common questions about wetland projects is: Should I add fish, frogs, or turtles? There is no need to add your own frogs or turtles (unless your site is in an enclosed area or highly urbanized) as they will find their way to the wetland if it meets their habitat needs. Because many amphibian species only use wetlands to lay eggs, the adults may not be seen. Other species are more water dependent and will inhabit the wetland longer. Fish will unlikely colonize your site unless it is connected to a stream or river system. Since fish eat tadpoles, many species of amphibians will only lay their eggs in wetlands that do not contain fish. The majority of fish species require 4' of water to survive winter freeze and summer heat. Therefore, a decision to include fish will be based on: a) a wetland having a deep area where fish can survive and, b) an interest in providing habitat for fish. Since there is a worldwide decline in many amphibian species, it is recommended not to add fish unless they meet a specific educational goal.

Cost

The cost of constructing a wetland can vary widely depending on size, amount to be excavated, amount of work, and materials donated. The following list gives some general thoughts about costs:

- Design: On an existing site, the county Soil Conservation Districts are very helpful at completing wetland designs at no cost. The U.S. Fish and Wildlife Service is also available to consult on design. Engineering firms or universities may be able to complete designs at no cost as a public service. Some county public works engineers will provide design assistance. On a new school site, the cost of designing a stormwater wetland should not be significantly more then the typical stormwater management pond.

- Construction: Earth moving can range anywhere from $1.80 to $4.00 or more a cubic yard. Contractors have been very generous in providing excavation at reduced rates or at no cost when approached to excavate a wetland for an existing school site. For new school design, the excavation costs of a good wetland design will be slightly more than a typical stormwater management pond.

- Construction materials: Seed, straw, and erosion control fence shouldn't cost more then a few hundred dollars.

- Plants: For a 1/4 acre wetland site, plants can be purchased for $500 - $1,000. Grants are easily obtained to cover all the costs. Natural colonization of wetland plants will fill in any gaps. In subsequent years, focus on planting a shrub or meadow buffer around the wetland.

The Chesapeake Bay Trust (410-974-2941) and Department of Natural Resources Aquatic Education Program (410-260-8716) can provide funding for plants, educational materials, and possibly construction costs. The U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program (410-573-4500) can provide technical assistance and a limited amount of funding.

Student Participation

Student participation should be a primary focus of the project as students will take ownership of the wetland if they participate in the planning process. This is especially true for establishing a wetland on an existing site. Some of the ways students can get involved include:

- completing an initial site study,
- sketching a concept design for the size and shape of the wetland,
- selecting plant species,
- developing a planting design,
- installing plants,
- watering plants,
- writing grants,
- soliciting donations from parents and businesses,
- writing a press release, and
- presenting the project to the community and board of education.

Since each project is different, teachers can work with a natural resource specialist to decide how students can be involved. The U.S. Fish and Wildlife Service has developed a guide to help teachers lead their students through the process of planning a wetland. For a copy of this publication call 410-573-4500.

Safety

Slopes adjacent to and within the wetland should be very gentle. Water depths should be kept under 2 feet. Following these basic guidelines will insure a safe wetland site. Fencing should only be used if required. Fencing isolates the wetland from certain wildlife species. Fencing also sends a confusing message to students about natural areas being dangerous or off limits.

Other Concerns

Mosquitoes - Many mosquito species breed in temporary pools of water that lack larval predators. Established permanent wetlands with aquatic plants have a variety of aquatic insect predators including dragonfly larvae, diving beetles, and water striders that

eat mosquito larvae. A small established wetland will harbor a few more mosquitoes then upland habitat but it should not significantly add to the local mosquito population. If mosquitoes become a major problem, mosquito fish can be added to the wetland. They are available from the Maryland Department of Agriculture.

Snakes - Snakes are part of the natural ecosystem that play a key role in the food web both as predators and prey. **There are no poisonous water snakes in Maryland.** The northern extent of the poisonous water moccasin is in the Great Dismal Swamp in Southern Virginia. Young northern water snakes have a banded pattern and have been confused with water moccasins. Northern water snakes can be quite curious and sometimes aggressive. However, they are not harmful and will not bite unless provoked.

Plants of Concern - No plant parts should be eaten unless known to be edible. Stinging nettle is a plant that should be removed if found on site. Rice cutgrass (a native wetland plant) should not be planted as the leaves have sharp edges and can cut skin.

Regulatory Requirements

Wetlands are regulated by Section 404 of the Clean Water Act. A permit is required when a wetland is disturbed or altered. If a site has wetland characteristics (persistent saturated or ponded soil, gray or mottled soil color, and or hydrophytic vegetation such as rushes, sedges, or cattails) invite a representative from the Maryland State Department of the Environment to the site to make a decision on whether a permit is needed. If the site is an upland no permit is necessary. A sediment and erosion control plan is needed if more then 5,000 sq. ft. of soil is disturbed.

Arbor
Judith A. Resnick Elementary School
Montgomery County Public Schools

Case Study: Gardens

The Judith A. Resnick Elementary School in Montgomery County was an attractive new brick school wrapped around a 80′ x 120′ courtyard crisscrossed with concrete paths and dotted with unremarkable vegetation. Corridor and classroom windows looked onto the courtyard; the media center and corridor doors open into it. But there was nothing to see and no reason to enter it. In 1995, with the support of the principal and staff, the PTA undertook as its goal a three year transformation of the courtyard into an outdoor science center/garden. The purpose of this effort was to provide hands-on opportunities to enrich and supplement classroom instruction. With the help of a wildlife specialist, they developed a wishlist of features which included ponds (a control and an experimental site), raised-bed gardens (approximately 40 of their 630 students are orthopedically disabled), an extensive arbor to provide shade and to act as a climbing structure for vines, a Colonial Maryland herb garden (including medicinal, culinary, and dye plants), a butterfly garden, a wildflower garden, a weather station, a composting site, seed planting areas, and wildlife habitat.

The plan was implemented in stages. First, the ponds were dug. They were placed next to the corridor windows where passing children could see the new pond lilies unfold into bloom and monitor the darting native fish. Next, the existing alkaline soil was heavily amended to allow the planting of native (acid-loving) plants. This took a year of planning, fundraising, and working. A biologist parent took the lead in coordinating the project. Her family lived across the street and spent endless hours developing and tending the courtyard. (A plan for rotating the care during the summer, using a different family a week worked better on paper than in reality).

In the next phase a crane lifted timbers over the school building to create the arbors. Native vines were planted at the bases of the uprights. A shed for garden tools was added as were covered plastic vermin-proof composting bins (to which children add their lunch scraps). Raised beds, at wheelchair height, were filled with composted leaf soil, and planted with quick-crop vegetables. Bird feeders and a sundial in which children stand to make the shadow add to the educational opportunities.

Raised, ADA Accessible Garden
Judith A. Resnick Elementary School
Montgomery County Public Schools

Exploring the Garden
Judith A. Resnick Elementary School
Montgomery County Public Schools

Children have been involved in all phases of maintenance and in monitoring the growth and changes in the courtyard. Monthly newsletters keep the staff and community abreast of any interesting developments. An annual "Courtyard Guide" has been published and distributed to all staff members, complete with a reduced copy of the original plan and with information on all of the resident plants and animals. At first, only a few teachers used the courtyard, but usage has increased substantially as the curricular connections have become apparent.

Contribution to Educational Programs

Gardens discussed in this section are of the traditional flower-and-vegetable type, familiar to many adults, and found around many homes in borders and containers. Adult familiarity is a great advantage of these gardens -- many teachers and aides feel they can guide children in the process of selecting, planting, and tending to plants so readily available in garden stores. The job of facility planners, architects, landscape architects, and curriculum planners is to facilitate school gardening through thoughtful design.

Gardening is a worthwhile pursuit for children and adults of all ages and abilities. As a vehicle for interdisciplinary environmental education, gardens are excellent. Many science, math, social studies, and language arts goals for Maryland students can be approached through gardening. Understanding of life cycles and the interdependence of living organisms and the non-living environment are examples. Because gardening is such a flexible, adaptable activity there is no set of specifications, but rather a set of guidelines to be adapted for different aged children and different school sites.

Planning, Design, and Construction

Locating Gardens

Gardens need light, water, appropriate soil, drainage, and protection (e.g., from balls, foot traffic, and roof drainage). If possible, school gardens should be located close to classrooms so they can easily be tended and monitored by children and teachers. Gardens must be accessible to individuals with disabilities. Secure storage space for tools and equipment should be nearby, as well as provision for properly vented and protected composting. Water must be easily accessed.

IDEAS FOR GARDENS

Native American Three Sisters: corn, beans, squash
Salsa: hot peppers, tomatoes, cilantro, onions
Quick Salad: leaf lettuce, radishes
Butterfly: native plants to attract native butterflies
One Color: choose a color and see how many shades exist
Wildflower: include black-eyed Susan, Maryland's state flower
Colonial Maryland: medicinal, culinary, and dye plants
Persian Rug: children make a pattern and plant it with flowers
Multicultural: plants or seeds from children's countries of origin
Alphabet: marigold's for "M", etc.
Xeriscape: plants that once established survive with little or no watering

Table 6

Classrooms in many schools have doors that lead directly outdoors, providing access to gardens. Gardens should be located far enough away from structures to allow children to work on all sides of the garden. In new construction, each garden should have a water supply; retrofitting can extend an existing water supply to the outside of the building.

Courtyards are prime garden locations as they can provide security for the gardens and equipment shed, access to water, low traffic, and interesting views for adjacent rooms or corridors. Materials used in courtyards should be selected to control excessive heat from the sun. Retrofitting courtyards may be more difficult than adding to the perimeter of the building (e.g., delivering large lumber for a courtyard arbor or new soil and timbers for raised beds).

For an extensive garden area, one elementary school created 108 4x6 foot plots, located a storage shed/ greenhouse with multiple hose bibs in the center, and ringed it with a fence including a locked gate. There was a garden plot for every four children. Secondary schools, particularly ones with a related educational focus, may require a similarly large area for curriculum.

Providing water is necessary if extensive gardening is foreseen. It is vital that water is close to the gardens, otherwise the labor of tending the plants becomes too burdensome for all but the most dedicated teachers, students, and parents.

Flower and vegetable gardens require a minimum of 5-6 hours of sunlight. The garden area must be carefully selected to avoid long periods of shade from the school building or from trees.

Gardens should be a permanent part of the school design and should not be located where expansion is slated to occur. Good gardens should last for years with the soil constantly being improved and perennial growth encouraged and monitored. Gardens typically require a great deal of work by teachers, parents, and custodians; providing permanent locations for gardens respects and sustains this work.

If children's gardens are to be considered a positive part of the landscaping of the school, just as children's art is considered desirable interior decor, similar aesthetic standards need be applied. If there is a preference for a formal landscape in highly visible areas, such as the main entrance, locate children's gardens less conspicuously.

Soil - In new construction, some of the site's topsoil should be reserved for school gardens, a step which is both practical and provides an authentic basis for growing native species. In adding gardens to existing buildings, fresh soil and amendments will usually be required, particularly if beds are near the buildings where soil is usually poor. Bulk top-soil is of uneven quality and therefore, should be purchased carefully. A composting program will contribute to soil quality in an ongoing garden program.

Inexpensive soil testing by the Cooperative Extension Service provides information on minerals, nutrients, and pH values. Lead testing is recommended for older school sites. If lead is present, replacing existing soil with fresh soil is the only alternative.

Types Of Beds - Garden beds range from ground level to wheelchair accessible level. Raising a bed 8-12'' high delineates it from its surroundings so it is not disturbed by pedestrian traffic. The top should be

suitable for sitting (wide and smooth, with rounded edges). Some beds for prekindergarten and elementary school children should be 22-28'' high to meet the requirements of the Americans with Disabilities Act for accessibility. For secondary school children, a 20-30'' bed height will provide accessibility. The advantages to raising beds are protecting their contents, especially in high activity areas, allowing drainage, and simplifying soil preparation. For ideas on accessible gardens, see The Enabling Garden (page D-2, References).

The size and shape of beds vary enormously depending on the site. Narrow rectangles allow children to work easily without getting into the garden. If squares and circles are used, paths are needed. One school created a large square garden available to young children by using large tiles to create a checkerboard of soil and working spaces where children could kneel and sit. A series of planters can be arranged to give children the interest of pathways.

Obviously, cost varies with the size and materials used. A recently constructed 4'x12'x3' bed using 6''x6'' timbers, lined with filter fabric (to prevent soil from seeping between the timbers) cost about $1000 for materials and labor. See Play for All Guidelines (page D-2, References) for further ideas on creative garden design for schools.

Plantings - Plantings vary according to the goals set for the garden. A class of 4-year-olds may want all red flowers, chosen from seed catalogues; a class of second graders may want to select plants in hopes of attracting butterflies as part of their life cycle studies; a kindergarten class studying nutrition wants a vegetable garden; a fourth-grade teacher may want to plant colonial species to enrich a social studies focus on Maryland history; the art teacher may want a sunflower bed to link with paintings by Monet, O'Keefe, and VanGogh; and social studies and science teachers may want only native species to teach a sense of place and environmental sensitivity. Well designed and constructed gardens accommodate all these curricula.

Long Term Maintenance

The most common downfall of school gardens is lack of maintenance when school recesses for the summer. There are two ways to handle this potential problem. The first approach is to have someone, or ones, tending the garden: a community group, e.g., a Boy Scout Troop, the same dedicated parents and teachers who started the garden, a summer school teacher, or a school neighbor. Access to water and good mulching go a long way to making the job easier for these gardening stalwarts. If considerable funds and time have been invested in perennials and shrubs, such on-going maintenance is necessary.

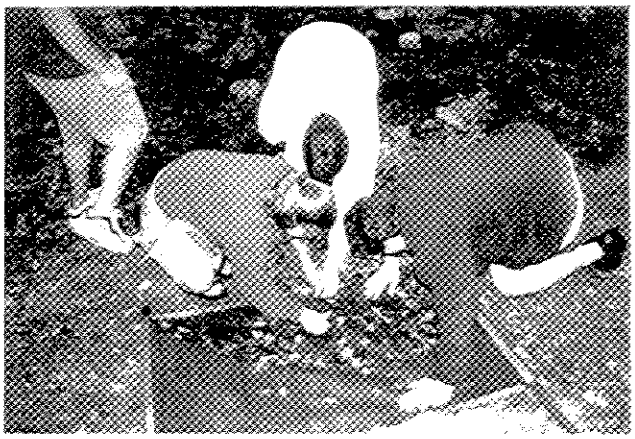
The second approach is to use the garden only for plants that mature by May having been planted earlier in the fall or spring (peas, lettuces, radishes, pansies, and bulbs such as tulips) and for plants that can be planted in late August or September and mature by the end of October (spinach, beets, chard and lettuce from seed, broccoli from seedlings). When fall vegetables are harvested, spring bulbs and pansies can be planted. When peas are planted, potatoes can be also planted -- being fairly sturdy they might make it through the summer untended and can be a total delight to dig up in September. A big garden might have room for Heritage raspberries that do not need significant tending, bear fruit in the fall, and are trimmed down before the next growth in the spring. If there is space for sprawling, planting and mulching, pumpkin seeds might provide a fall crop, given any luck with summer rain for watering.

If the decision is for no summer growing, the garden should be cleaned up and mulched as school closes in June to avoid an unsightly weed patch the seeds of which will haunt all future efforts. A fall clean-up is necessary and fall is also a good time to add in the compost that has been accumulating.

Student Participation

Working within the considerations suggested above, secondary students can contribute substantially to making gardens; elementary students are more appropriately provided good beds in which to experiment with varieties of plants and arrangements. With a good bed, children can devise many interesting conditions of soil, light, water, and temperature to study plant growth, as well as help decide the type of garden.

STREAMS



Students Sifting for Microinvertebrates
Towson High School
Baltimore County Public Schools

Students Studying Health of Streams
Towson High School
Baltimore County Public Schools

Case Study: Streams

At Towson High School in northern Baltimore County, the 11th and 12th graders are learning about and restoring a schoolyard stream environment. As the final project for the Chesapeake Bay Course (one semester/elective), students were assigned a small, three meter wide, riparian area to restore. Using the Save Our Streams publication, *A Citizen's Streambank Restoration Handbook* (page D-2, References), students assessed the stream, developed a restoration plan, then carried out the restoration. The 1997/98 school year was the first year of this project.

Funding for this stream restoration was provided by the Herring Run Watershed Association and the Baltimore County Forestry Board for trees and the Chesapeake Bay Trust for chemical kits.

The teacher of the Chesapeake Bay course at Towson High School said, "One of the goals of this class is to teach students ways in which they can actually do something to help the health of the Bay. We go by the motto of 'Nobody made a greater mistake than he/she who did nothing because they could only do a little.' Along with the community newsletter distribution and the stream restoration, the students actually make a contribution to saving the Bay."

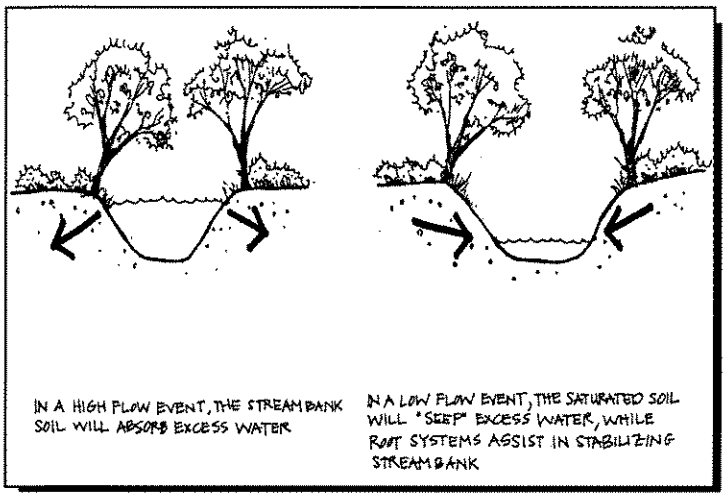
Environmental Enhancement

Stream ecosystems that flow on a school site provide many opportunities for students, faculty, and administrators to learn about local water quality and wildlife habitats. These unique ecosystems are the school's direct link to the Chesapeake Bay and Maryland's efforts to restore this endangered estuary. As stewards of a school site stream environment, students, teachers, maintenance, and administrative staff have an opportunity to learn about and understand how streams work, hopefully becoming active in projects that will protect and restore these fragile ecosystems so vital to the Chesapeake Bay.

Ways in Which Healthy Stream Ecosystems on School Sites Help the Environment

- Provide protected areas along stream banks, for trees and wetland plants. These areas known as, *riparian buffer zones* should be not less than 25 feet in width.

- Wildlife use forested buffer strips to travel to and from feeding areas, and for seasonal migrations. These corridors are located along streams because stream buffers provide shelter and protection from predators and human disturbances.



Streambank Vegetation Serves Many Purposes Figure 8
(Izaak Walton League of America)

- Riparian buffer areas provide opportunities for students to design and implement habitat enhancement projects such as bird, squirrel, and bat boxes, as well as tree and shrub plantings to attract wildlife.

- Stream buffers can filter stormwater runoff from athletic fields, tennis courts and buildings.

- By planting trees within the riparian buffer, students will be actively participating in a new statewide mandate to plant 2,010 miles of streamside buffer strips by the year 2010. The Maryland Department of Natural Resources Forest Service can provide advice and trees for many planting projects on public land. This effort will help Maryland meet a very important goal to improve local water quality and ultimately restore the vitality of the Chesapeake Bay.

Contribution to Educational Programs

A student's educational program from elementary age through high school can be enhanced by learning outdoors. The opportunities to apply lessons to local environments and environmental issues, specifically using elements of a local stream system are limited only by the imagination of the teachers.

Having a stream ecosystem and its associated riparian buffer on or near campus is a valuable opportunity for teachers and students to get involved with global issues and efforts to improve their environment. Stream ecosystems are an excellent resource to:

- Begin investigations in the fields of physics, engineering, geology, and biology. For example, stream velocity and channel sinuosity studies can help students learn real life applications for mathematical studies.

- Conduct research on fish species and aquatic habitats.

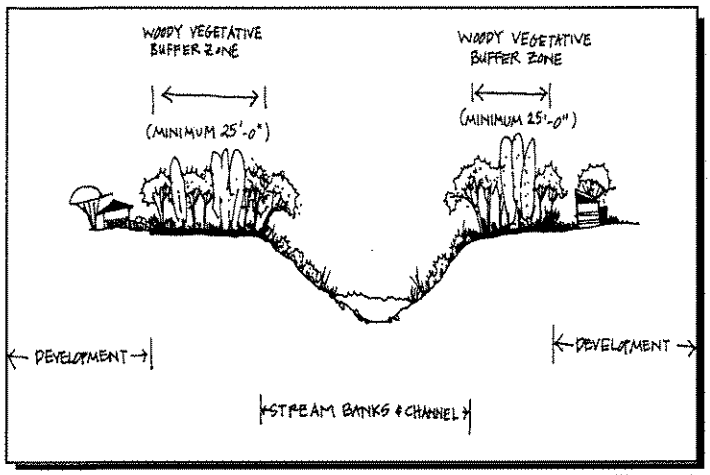
- Develop and implement habitat enhancement projects that could provide for student service learning credits and valuable lessons regarding environmental stewardship.

- Provide inspiration for students writing and art expressions about their local community or a natural ecosystem.

Planning, Design, and Construction

As the appointed stewards of public land, school facility planners, and administrators are charged with an enormous responsibility to consider all phases of a construction operation and how a project will affect local waterways. Most of these considerations are directed by state and federal laws, but many design and construction decisions and activities can be geared toward how to better protect a school site stream, or in the case of a stormwater retrofit, improve the ecosystem for future generations of students.

Infiltration is vitally important for stream protection. The dynamic, yet stable geometry of stream channels evolved in mostly forested watersheds where 85% of runoff entered streams slowly through groundwater seepage and 15% from overland flow. In watersheds where a significant amount of forest is cleared, the percentages are reversed. Overland flow translates into large volumes and increased velocities causing streambank erosion that smothers aquatic life and fills navigation channels with silt.



Riparian Zone Vegetation Figure 9
(Izaak Walton League of America)

Through planning of construction projects, consideration should be given to stream protection beyond mandated guidelines. Every opportunity should be made to promote infiltration of rainwater. This generally means reducing the quantity of stormwater from a site that is directed to a basin. A variety of techniques used at a smaller scale throughout a site can greatly aid infiltration while significantly reduce or eliminate the need for stormwater management basins. Some of the techniques include bioretention (rain gardens), open grass swales, sand filters, wetlands and porous pavement. Many resources are available on this topic. A local group, the Center for Watershed Protection, has two excellent design manuals: Design of Stormwater Filtering Systems and Site Planning for Urban Stream Protection (page D-2, References).

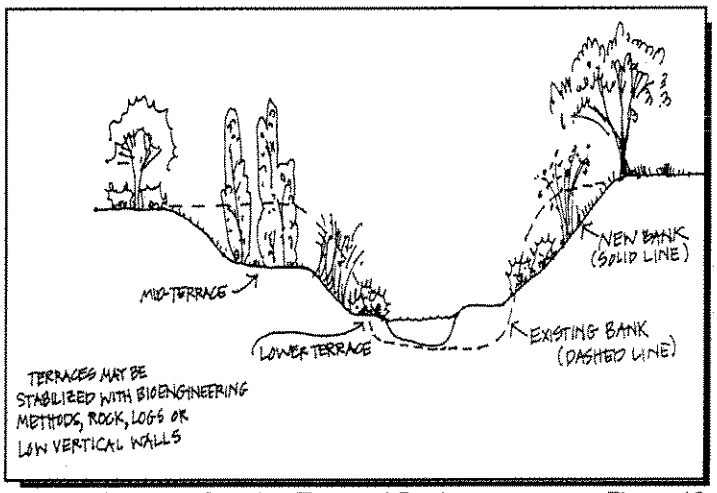
There are five different physiographic regions in the state of Maryland. They are: *coastal plain, piedmont, blue ridge, ridge and valley, and the Appalachian plateau.* These areas are defined by distinctive geographical features. Each of these regions have specific types of watershed characteristics and runoff patterns with regard to stream ecosystems. It is important to know in which type of physiographic region your stream is located. This information will lead to a better understanding of drainage patterns on and around the school site and will help school staff understand more about the aquatic species and habitats of the stream.

When planning for school facilities, it is imperative that certain school operations be located away from stream areas and that adequate stormwater considerations be addressed so that these operations will not affect the water quality and buffer stability of the riparian areas.

Stormwater Runoff Areas and Pollution Sources

- school maintenance areas
- cafeteria and kitchen
- athletic fields
- green houses
- basketball and tennis courts
- parking facilities
- career education facilities for programs such as automotive services, carpentry, small engines, and welding areas

Any construction project, whether it is new construction or renovation of an existing facility, which disturbs 5,000 square feet of soil will require an approved sediment and erosion control plan. Check with the appropriate county agency for details. Construction projects should be designed to avoid disruption of stream buffers and 100-year flood plains. If



Stabilize Slope by Creating Terraced Banks Figure 10
(Izaak Walton League of America)

construction in the floodplain or 100-year floodplain is unavoidable, as in a road or trail which crosses a stream, permits will be required from Federal and/or State regulatory agencies. Contact the Maryland Department of the Environment to determine specific requirements.

One relatively new and interesting stream rehabilitation effort emerging on the environmental restoration scene is the concept of "*daylighting*". This is an attempt to take long buried stream hydrologic systems and restore them to free flowing uncovered environments. Although costly, stream *"daylighting"* is a worthwhile project. Many streams that used to flow through neighborhoods were encased in concrete culvert type structures years ago to facilitate the building of roads, communities, schools, and even athletic fields. The idea was that by burying the stream, the developers could better control stormwater runoff and erosion. With recognition of the value of having an ecologically viable stream in a community, restoration efforts are increasing that remove culvert structures and restore a stream's natural channel and flow. For more information about stream "*daylighting*" call the Coalition To Restore Urban Waters coordinator at the Izaac Walton League of America (1-800-BUG-IWLA).

Long Term Maintenance

Riparian buffers should require little maintenance if they are not excessively disturbed. However, it may be necessary to do periodic planting if school activities result in damage to vegetation. If exotic invasive vegetation (e.g. Japanese honeysuckle, oriental bittersweet) is overwhelming native vegetation, a control program may be necessary.

Trails or roads which provide access to or cross streams should be checked on a regular basis to ensure that erosion is not occurring.

Stormwater management facilities must be maintained on a regular basis to ensure that they are functioning properly and are in compliance with applicable statutes, such as the Maryland Dam Safety Regulations. Areas downhill of all school facilities, including athletic fields, should be checked periodically to ensure that runoff is not causing erosion.

Student Participation

Student participation can take many forms as suggested by the following examples:

- Site rehabilitation concept and design--identification of problems and design considerations.
- Organize a group project to remove stream barriers to fish migrations (be sure to call a local stream ecologist before removing instream barriers such as tree limbs--they could be providing important aquatic habitat for insects and fish).
- A stream clean-up is an excellent way to improve not only water quality but the aesthetic quality of a stream environment and it encourages stream neighbors to do their part to keep out trash.
- Buffer planting--all phases from design to implementation.
- Stormwater retrofit--students working with engineers and landscape architects.
- Public education campaign--write an article for the school newsletter, contact the local paper or submit a letter to the editor, organize and host an education forum for the neighborhoods along the stream, produce a public service announcement for the local cable TV station.
- Grant writing--students can write a grant to help fund monitoring equipment and restoration materials.
- Learning about the County/Municipal permit processes.
- Fundraiser--have some fun--throw a party to raise awareness and money to support the project.

Safety

All activities outdoors involving student groups should follow precautions to ensure the safety of those working in or along waterways.

Stormwater-flooding - Throughout Maryland's Piedmont and coastal plain regions, flash flooding during and after severe rain showers can be a threat to human safety in and along stream corridors. In highly impervious urban areas this situation is more prevalent

and should be identified to all teachers and student groups involved with stream studies. Most radio and TV weather reports will include flash flood alerts. Teachers and students should cancel all stream related activities if the local weather forecast includes a flash flood alert.

Access-Erosion - With all outdoor activities, footing on uneven ground can be hazardous. Stream banks are dynamic environments and care must be taken to identify safe access areas that do not require students to climb down steep or highly eroded banks. Access areas should be relocated over time if large numbers of students are using them. This will lessen the impact to the bank and ensure the safety of the students.

Remote Study Areas - Stream corridors are usually heavily wooded and located away from school buildings. Students need to stay with a group or a partner during all stream related activities. Care should be taken walking in streams because of algae covered rocks, soft sediment, or submerged objects. Students should wear only shoes that tie on or boots - sandals are not recommended. A cellular phone or hand held two-way radio should be carried by a teacher to contact the school in the event of an emergency.

Pollution - Because streams are located at the lowest point in watersheds, trash and woody debris are constantly being washed into them during storm events. In addition, the remoteness of these environments can attract illegal dumping of trash and yard waste. It is imperative that teachers scout a stream site before student trips. Such hazards could include hypodermic needles, broken glass or drums with unidentifiable substances.

Water pollution that is hard to identify such as an oil or chemical spill can be dangerous to human health. Before students enter a stream, the teacher or group should scan the water surface. If the water is cloudy or has an unusual color or odor do not allow the stream water to come in contact with the skin, mouth or eyes until it has been checked out by a local water management authority. It is imperative that a student or teacher report all suspicious water pollution. The Maryland Department of The Environment has a water pollution hotline; (410) 974-3551, and so do many local government agencies and public works departments.

Regulatory Requirements

Streams are regulated as wetlands under section 404 of the Clean Water Act. Additional regulations may vary by location, water use classification, and county. Check with the Maryland Department of the Environment and appropriate county agencies to determine which regulations apply.

References

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Table 7

Chapter 4

Other Considerations

Paths

Structures

Habitat Components

Boardwalk
Yough Glades Elementary School
Garrett County Public Schools

PATHS

Boardwalk, Yough Glades Elementary School
Garrett County Public Schools

Paths to and through natural environments on school sites must be accessible to individuals with disabilities. The surface must be stable, firm, and slip resistant. Soft, loose, or irregular surfaces will hamper the movement of a wheelchair and create hazards for people using other mobility aids. Often the settings for these paths make concrete inconsistent with the look and experience desired for students and staff. These paths are sometimes lengthy which precludes the use of more costly materials such as concrete. For these reasons, other materials need to be explored that meet aesthetic, cost, and accessibility requirements. The project architect will have to study the slopes, soils, and other aspects of the location for the path, to determine the best specifications.

One type of path that has had success in national parks is one with a compacted aggregate base and a crusher run top surface including an additive material to stabilize the surface. The subgrade should be compacted to 95% density. If there is concern about vegetation growing through the path surface, a geofabric should be placed underneath the base course. All existing vegetation should be removed or killed prior to placing the fabric. The base course should be 2-4 inches of crushed aggregate compacted to 95% density. If possible, use a steel-wheeled vibratory type roller, otherwise use nothing less than a vibratory plate compactor. At least three passes of the compaction equipment should be used. The finish surface should be 2 inches of crusher run, 1/4'' aggregate and less, with an added stabilizing material. The finish surface should be steel wheel rolled. The path should be edged. One inexpensive edging is PVC designed for that purpose with 2'' x 2'' stakes 48'' on center.

The width of the path should be 36'' - 48'' but can be narrowed to 32'' - 36'' for short distances if the path must pass through restricting natural settings such as rock formations or large trees. Level 60'' x 60'' rest and passing areas should be provided every two hundred feet. Ideally, the path should not exceed a 5% slope (1:20). If the slope of the path does exceed 5%, that portion of the path is classified as a ramp and should have level landings every 30 feet. In all cases the maximum slope of a ramp is 1:12.

There are several types of stabilizers. Class "C" flyash is an inexpensive stabilizer provided there is a source of this material relatively close to the construction site. The quantity of quicklime in flyash varies from place to place. Class "C" flyash contains a sufficient quantity of quicklime to be of benefit when stabilizing surface material. The flyash helps to cement the aggregate particles together and this takes place when moisture is added. Usually about 5% flyash is used by dry weight of materials being stabilized. A good practice is to complete a test area to determine the exact amount of flyash to be added. Once moisture is added to the mixture of crusher run and flyash, the surface should be quickly leveled and compacted since the material may set-up in as little as fifteen minutes.

Another stabilizer choice is ground seed hulls, a patented, organic, nontoxic material manufactured from the seed hulls of the plantego, a plant native of Arizona. This product has been manufactured since the mid 1980's. The stabilizer is odorless and will not stain the materials it is mixed with. It has been successfully used in cold climates and works well with surface material that are 1/4'' or less in diameter. With

a 2´´ deep surface material about one pound of stabilizer is used for every 12 square foot area. Applying the stabilizer involves thorough and uniform mixing, watering, and compacting. The finish surface will soften when it contains moisture, during and after a rain, but will stabilize as it dries out. The stabilizer is easy to repair when the surface material is damaged by reforming the damaged area, rewetting, and compacting. If additional material is needed, the aggregate and stabilizer are mixed, placed in the location, graded, wetted, and compacted. This stabilizer material is available from Stabilizer Solutions, Phoenix, Arizona, (800) 336-2468. A discount is given for school use.

A third method of stabilizing a trail surface is the macadam construction technique. This method consists of a layer of non-woven geotextile covered with a 1/2´´ to 1´´ layer of aggregate chips or pea gravel which is lightly compacted. The aggregate is then coated with an asphalt emulsion at the rate of approximately 1.5 gallons per square yard. The asphalt emulsion will bond the aggregates together, as well as adhere to the geotextile which helps to disperse the weight of the trail traffic over a larger area. A thin layer of blotter sand can be spread over the surface to hide the black appearance of the asphalt.

For additional information on path stabilizers the USDA-Forest Service should be contacted at the San Dimas Technology & Development Center, Attn: Recreation Program Leader, 444 East Bonita Avenue, San Dimas, CA 91773, (909) 599-1267.

In wet areas or where there is a significant amount of surface water drainage, a raised boardwalk should be the "path" of choice to protect the natural environment, allow observation of the natural environment, and provide an accessible route. Boardwalks should be a minimum of 48´´ wide. If 60´´ x 60´´ rest and passing areas are required due to slope, they can be enlarged and placed more frequently then every two hundred feet. As such, they can serve as study areas for groups of students without restricting traffic along the boardwalk. Even if not required, these areas are desirable. Protection along the edges of the boardwalk is required for wheelchair users, individuals with mobility problems, and for the general safety of students and staff. Boardwalks can be designed with a railing, however, a low railing should be designed so as not to hamper the view of the surrounding area and add significant cost to the project. An inexpensive but effective solution is to provide a simple wood edging (lip) along the walk and a single, low railing.

STRUCTURES

Whether built as part of a major school construction project, or as an enhancement to an existing school site, outdoor structures can help conserve ecological features and enhance instructional objectives.

Ecological features like ponds, streams, wetlands, meadows and woodlands are home to many animals. Structures help shield sensitive plants and wildlife from human disturbance and define physical spaces where student activities may be concentrated. Structures also help address the seemingly incompatible juxtaposition of sports fields, playgrounds, parking lots and school site habitats.

Structures create unique opportunities for students to interact with, observe and research the natural environment at their own pace. Such opportunities enhance instructional objectives in math, science, language arts, creative arts, social studies and other disciplines. Structures make outdoor instruction more comfortable and convenient. They create spaces for structured learning that facilitate behavior management outside the classroom.

School site habitat structures — their planning, design, construction and utilization — provide opportunities for school partnerships with the community, conservation organizations, arts associations, local businesses, media outlets and government agencies. These interactions may demonstrate to students career opportunities in the areas of environmental planning, ecotourism, journalism and wildlife management.

While many kinds of structures may be included in a school site habitat or outdoor classroom, several types have been used successfully in Maryland and are included here. They include: seating, wildlife viewing blinds, and outdoor classroom buildings and storage.

Planning, Design, and Construction

Seating, Work Surfaces

Tables, benches, and other seating structures commonly are included in outdoor classrooms. Planning, design and construction considerations will help determine the best seating structures for your site. One of the first considerations is whether the seating structures will be stationary (fixed in place) or mobile. Stationary seating may be secured so it will not tip on uneven surfaces. Stationary seating can be constructed using heavy, durable materials and does not require storage. Stationary seating may require a water permeable substrate, such as wood chips or stone pavers. Careful attention should be given to the placement of stationary seating. Noisy, high activity areas, low lying wet areas, and areas that offer no protection from heat and wind should be avoided. Stationary seating may be more vulnerable to vandalism. Placing the seating area where it can be monitored visually may be an important consideration.

While stationary seating offers many benefits, it does not offer the option of moving the seating structures to where "the action is." Movable chairs or benches may easily be placed in a meadow filled with blooming daisies, beside a stream covered by racing water striders, or beneath an oak dropping its golden leaves.

Another consideration is the grade level and number of students who will be using the seating. Younger students require lower seating. Benches, instead of chairs, may better accommodate large class sizes. Special needs students may require especially stable seating with back and arm supports.

The type of activities is another consideration. While seating alone may be adequate for reading or observation, tables may be required for writing, research and arts activities.

Seating structures are inexpensive to moderate in cost and are limited in design only by the imagination of the planning team, teachers and students. Simple natural objects like large stones, logs, or stumps may be fashioned into inexpensive outdoor seating. Preassembled picnic tables or picnic table kits provide a commonly used outdoor seating structure at a low cost. In some cases, individual, mobile seating may be desirable.

Wildlife Viewing Blinds

Wildlife viewing blinds can be one of the most engaging structures in a school site habitat. Patient students, rewarded with an intimate glimpse of a young squirrel struggling to outsmart a student-designed, squirrel-proof bird feeder, for example, gain experience and confidence in their ability to apply principles of science and technology. Wildlife viewing blinds, however, represent an investment and require careful planning and design.

Planning and design begins with planners' and educators' expectations about the opportunities a wildlife viewing blind may provide. The best wildlife viewing blinds are those built in places where there is an existing, high level of wildlife activity and where that activity would be affected by human disturbance. Building a wildlife viewing blind will not bring wildlife to your site and a blind is not required to observe animals that are accustomed to human activity. While a new pond or wetland eventually may attract wildlife species that require a viewing blind to observe, expectations need to be realistic about the wildlife viewing opportunities, the student interest that will be generated, and the wildlife value of your site.

Once the kind of wildlife viewing opportunities have been determined, the real planning process can begin. Key considerations are site and access.

The habitat features of the site and the location of the blind within the site are key to the blind's success. The best sites are those that include a variety of habitats and ecotones — the zones where different habitats meet. For example, a pond or wetland bordered by a woodland on one side and a meadow on the other would optimize the diversity of wildlife that may be observed from the blind. The blind needs to be located near enough to wildlife activity for easy viewing and far enough away to prevent human disturbance.

The blind also must be sited to take advantage of natural lighting. An east-facing blind, for example would be good for afternoon viewing, but the rising sun may hamper morning viewing. A north facing blind will provide better foreground lighting, and give photographs and viewing a greater sense of depth. Often, there are few choices about viewing direction. In these cases it is important to anticipate and work around the blinds viewing limitations.

Another planning concern is access. A blind is successful if it can be entered and exited without disturbing the wildlife it was built to observe. This requires physical barriers and landscaping to shield human activity from the observation area. Wide earthen berms provide the most durable physical structures to facilitate undetected entry and exit. Once planted with vegetation berms absorb sound and, if positioned correctly, help conceal the viewing blind itself. Berms may be built using the soil removed to create a pond or wetland. They need not be more than about five feet tall, especially if they are planted with native evergreens. An alternative to earthen berms is stockade fencing, also planted with sound absorbing vegetation. Without these barriers, disturbed wildlife may not return to the observation area within a given period.

Once the site and access questions have been addressed the pre-construction planning of the wildlife viewing structure can proceed. Key issues to address are design and context. In the case of wildlife viewing structures, construction designs can be conceptualized by students and finalized by a professional designer. Students can design and install native plant landscaping and wildlife feeding stations that will enhance the use of the blind.

Many school sites do not have large natural areas and many do not merit a large, traditional-style observation blind. In these cases, low-cost alternatives may provide more appropriate wildlife viewing opportunities. For example, songbird feeding stations may be viewed from behind a section (or sections) of stockade fencing with small viewing openings cut at different heights. Stationary or movable benches can be placed on the student side of the fence to improve viewing comfort. Positioning this structure beneath a large tree or enhancing the fencing with native plant landscaping will provide a more concealed feeling for the student observer.

In one variation of the stockade fence viewing structure, fence sections are placed along three sides of a square. Using this design, a simple sloped roof can be added on top of fence posts that extend beyond the top of the fencing. Additional fencing or plantings can be used to create a concealed entryway. The ground where students are standing or sitting can be covered with wood chips. Wood chips are preferred because they make little sound when they are walked on and they are easier to maintain than grass or natural vegetation. In another variation, the fencing sections may be positioned in a concave arc.

To receive optimum use, regardless of the construction design, a wildlife viewing blind likely will need to be large enough to accommodate an entire class of about 25 students. The blind also will need to accommodate special needs students.

Some schools have constructed observation blinds as small as eight-feet by eight-feet. These structures work well for four to six students, but cannot accommodate an entire class. In places where smaller structures are used, special consideration should be given to the problems associated with the supervision of students using the structure, as well as those engaged in activities elsewhere.

Red Shouldered Hawk

Observation blinds, large enough to accommodate 25 people, were first built by environmental educators in British nature centers. Structures with this capacity need to be about 36 feet long and 10 feet wide. Entryways need to provide universal access.

The small viewing openings need to be low enough that seated students comfortably can see through them. They need to be covered by hinged shutters that can be opened easily and quietly. The shutters, opened only during observation periods, help minimize wildlife disturbances as students enter and exit. Stationary, tempered glass successfully has been used in some viewing blinds. The glass helps reduce noise levels and prevents students disturbing wildlife by sticking hands or objects out the windows.

Seating must be the appropriate height for the size of the students. Movable, stable bench seating works well. Hinged work surfaces, that can be raised or lowered, may be installed below the viewing openings. Exterior openings must be designed to prevent bright, backlit silhouettes of entering students from disturbing wildlife. This easily is accomplished by entry and exit doors separated from the interior viewing room by short hallways.

Graphics display panels along the back wall of the viewing blind may display student work or chart research project progress.

Locking exterior doors may help prevent vandalism and inappropriate use.

Air circulation vents, placed near the ceiling will alleviate excessive heat build-up on sunny days. Hinged shutters installed over the vents will reduce air circulation and trap heat on cold days.

Context is an important pre-construction consideration. A wildlife viewing blind is a unique opportunity to model ecologically sustainable design practices. The viewing blind unobtrusively should fit into the natural landscape. In many cases, the structure's design will reflect the site's natural features.

Special attention should be given to non-toxic building materials, finishes and colors. Wildlife viewing blinds in wooded areas may have log siding, stained to match the bark color of local trees. A blind in an area of rolling meadow may be built of cinderblock, covered by soil and topped with a living sod roof. Blinds near a marsh may be "brushed" with wetland vegetation the way duck hunters conceal hunting blinds. Wildlife species that are suspicious of human activity will be suspicious of anything that looks like a "building."

Eastern Tiger Swallow Tail

Many blinds are built on slightly elevated wooden deck platforms. A raised floor helps the view and is necessary if the blind is near enough to a water body that it may get wet during seasonal flood events. A wooden floor is easily swept clean.

While materials for a small observation blind may cost less than $2,000, materials for a structure large enough to accommodate an entire class will cost about $15,000 to $20,000. The advantage to the larger structure is that it can be used more regularly because it does not require additional adults to supervise students working in other areas. It also is easier for more than one class to use it each day. The larger blind provides greater flexibility and expanded opportunities to develop observation-based activities that help educators and students meet learning goals.

Outdoor Classroom Buildings and Storage

Most school yard habitats do not require auxiliary outdoor classroom buildings or storage areas. However, some schools have constructed covered pavilions with water and electrical power to use as outdoor labs. Covered pavilions offer some protection from weather. Screen-sided pavilions offer additional protection from biting insects. This may be a greater concern for schools located near wetland areas where biting flies, mosquitoes and other organisms may cause discomfort for students and teachers. Many examples of pavilions can be seen in public parks. Size, cost and design all will depend on a school's unique needs.

Storage areas can most effectively be provided using preconstructed storage sheds. These often are used for equipment storage by sports programs. They come in a variety of sizes and can be painted to blend with other school structures. They can be locked and even relocated as your storage needs change.

Amphitheaters

Outdoor amphitheaters provide a structured setting in which students may engage in a variety of activities. They provide areas where whole class instruction and discussion can occur. They provide an alternative and appropriate setting where working groups of students can report ecological data or research findings to classmates. Amphitheaters also provide a setting in which students can design and perform drama programs.

Many schools have small outdoor amphitheaters. They are relatively inexpensive to construct and maintain. While amphitheaters often are constructed on gently sloped ground, they also may be constructed on level surfaces. Whether on a sloped or flat surface,

amphitheaters should be located in areas where they are shaded from direct sunlight. If no shaded area is available, a simple pergola-type structure may be built to cover the amphitheater area. Native vines, such as trumpet vine may be grown on the overhead lattices of the pergola to create adequate shade and allow dappled sunlight to illuminate the amphitheater area.

An amphitheater typically consists of benches, arranged in a semi-circular pattern around a central raised deck or stage. As with other seating, the benches may be stationary or mobile. Most amphitheater benches are stationary. They easily can be constructed from pressure treated posts, set in deep post holes, and topped with a two-inch by twelve-inch lumber seat.

Small stages, usually about eight-feet by 10-feet in size, are built using standard deck construction methods. They should be elevated but must have access for individuals with disabilities. More elaborate stages may include eight to 10 foot tall vertical upright posts with horizontal cross beams on which backdrops and drama props may be supported.

The area around the stationary benches and stage easily can be covered with a thick layer or wood mulch. Underlying the mulch with a landscape weed barrier will reduce maintenance. The mulch will eliminate the need for mowing and trimming and also reduce bare earth and mud.

Some amphitheaters may include decorative or safety lighting, especially if they will be used at night.

HABITAT COMPONENTS

Outlined in this section are additional habitat features and suggestions for other outdoor amenities.

Habitat Features

Logs - Rotting logs are habitat for many insects, salamanders and small mammals. Logs are good lessons in the process of decay and the life associated with it. Logs can be placed in any of the habitat types. Partially submerged logs in wetlands or ponds provides a place for turtles and frogs to sun.

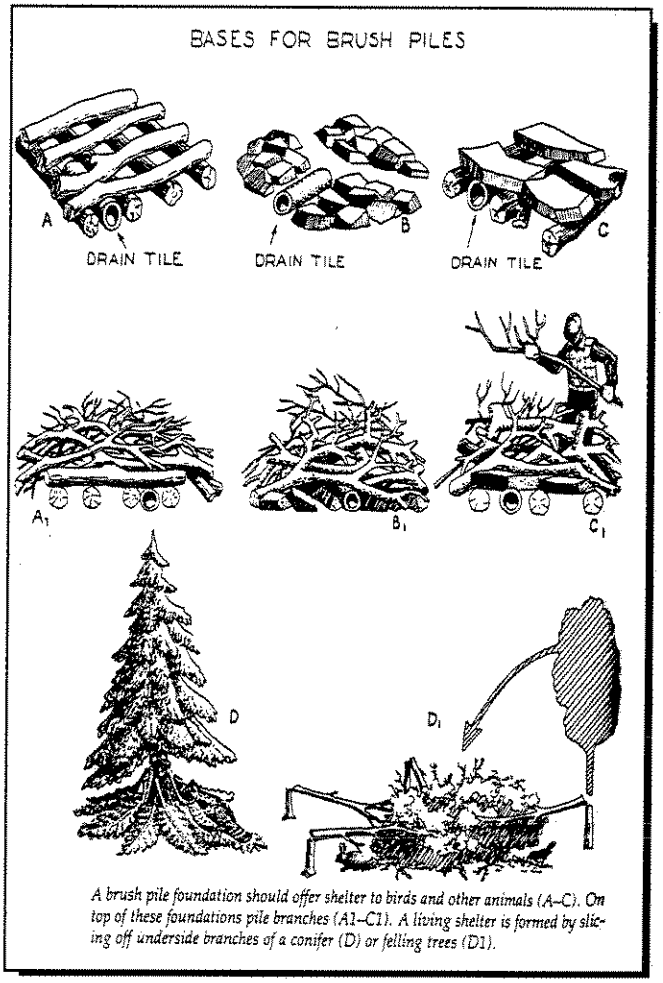
Snags - Standing dead trees or snags provide for cavity nesting birds including woodpeckers and chickadees. Insects within snags attract a variety of birds. Predatory birds perch on snags for a better view of prey.

Brushpiles - Brushpiles provide excellent cover for rabbits, chipmunks, skunks, small birds, and insects. Place brushpiles in woodlands and along wooded edges. Discarded Christmas trees can be used as a brushpile.

Water - If there is not room for a sizeable wetland or pond, consider a way to provide water for wildlife. A half barrel filled with water works well. If the soil has enough clay, simply dig a few shallow holes and let the rain fill them. Dripping water into a puddle is irresistible to birds. Check with a local library or nursery for directions on building a small lined pond.

Nesting Boxes - Nesting boxes are a good habitat amendment for cavity nesting birds. Bat boxes and squirrel boxes can also be built. A bluebird trail can be built by placing several nesting boxes at least 100 yards apart, preferably along a forest edge or in a meadow. Boxes need to be placed on posts with predator guards. Boxes should be monitored and cleaned after each brood. Many birds may use bluebird boxes for nesting. All birds, except house sparrows and starlings, are protected by law.

Feeders - Place bird feeders near protective shrubs and trees to attract more birds. A bird feeder project should have some long-term benefit for the students and not be a one-time project.



A brush pile foundation should offer shelter to birds and other animals (A–C). On top of these foundations pile branches (A1–C1). A living shelter is formed by slicing off underside branches of a conifer (D) or felling trees (D1).

Figure 11

Chapter 5

Appendices

Appendix A: **Funding Sources**

Appendix B: **Organizations**

Forest Service, Maryland Department of Natural Resources

Forestry Boards

Soil Conservation District Offices

Maryland Cooperative Extension Offices

Appendix C: **Native Plants**

Appendix D: **References**

FUNDING SOURCES

There is a wide variety of funding sources available to Maryland educators to support school site habitat projects, perhaps more than in any other state. In addition to traditional local and community fund-raising sources schools often depend on, many local and state agencies and nonprofit foundations that have programs designed for school site habitat restoration. Projects that connect with environmental restoration efforts, the Chesapeake Bay for example, are often especially fundable.

Not all projects will need funding. A reforestation project might be done with trees provided by the local county forestry board. Funding needs, and opportunities for funding, will vary depending on the type of project and size of project. The most expensive projects are those requiring large amounts of capital improvements. Most projects are much smaller and will cost less than $1,000. Larger projects can be done through a series of small grants.

One of the best sources of information about funding opportunities, as well as technical assistance for your project, will be state or local natural resource agency personnel. Many are listed in this publication, in the phone book, or on the Internet. School system environmental or outdoor education staff can be very helpful in finding resource agency help and funding opportunities.

In the last few years, hundreds of school site projects have been completed by students and teachers. Most of these have been designed as part of educational programs to improve student performance. Many others were part of statewide environmental restoration efforts. The following list includes major funding opportunities that have been supporting school site projects for many years.

The **Chesapeake Bay Trust** (CBT), a state foundation, is a source of funds and information. CBT has provided more than $500,000 per year to schools for projects connected to the restoration of the Chesapeake Bay. Funds collected through the sale of special license plates ("Treasure the Chesapeake" plates) and from a state income tax check-off program are available through a simple grant program. In addition to large grants approved regularly, projects for less than $1,000 can often be made in less than one month. Wetland restoration, riparian reforestation programs, and projects that slow or stop non-point source erosion, are examples of projects that receive CBT funds. More information and grant applications are available at (410) 974-2941 or at the CBT website.

The **Maryland Department of Natural Resources** (DNR) has several programs that provide assistance and funds to schools. Two programs frequently used by schools are the **Aquatic Resources Education** (ARE) program and DNRs forestry programs. The ARE program makes $1,000 grants available to teachers who attend ARE training workshops. Call (410) 260-8716 for information and the workshop schedule. Forestry programs include Arbor Day programs, local County Forest Conservancy Board programs, and Stream ReLeaf, a program to reforest Maryland stream buffer areas. For more information check Appendix B in this guide, the DNR website, or call (410) 260-8513.

The environmental education program of the **Maryland State Department of Education**, call (410) 767-0324, provides funds to school systems in support of their efforts to improve student performance through environmental programs. Many habitat projects can easily be designed to incorporate student achievement and problem-solving activities.

The "Partners for Fish and Wildlife Program" of the **U.S. Fish and Wildlife Service** (USFWS) has a limited amount of funding to assist schools with wetland, stream, meadow, or reforestation projects. Grants are usually less than $1,000. Some technical assistance is also available. Call the Chesapeake Bay Field Office of the USFWS at (410) 573-4500 for information about these opportunities.

Many national nonprofit environmental and educational organizations provide funds and other sources of assistance to schools. These include the National Arbor Day Foundation, the Federation of Garden Clubs, and the U.S. Environmental Protection Agency. One excellent source of assistance is the **National Wildlife Federation**. Their Internet web site, http://www.nwf.org/habitats/schoolyard/creating/index.html, lists many resources.

There are opportunities to include a school site project as part of new school construction or as part of major school renovation and/or addition projects. Please refer to Chapter 2, The Planning Process.

ORGANIZATIONS

MARYLAND DEPARTMENT OF NATURAL RESOURCES
FOREST SERVICE
Regional & County Offices

REGIONAL OFFICES

WESTERN REGION
3 Pershing Street
Cumberland, MD 21502
(301) 777-2137
(301) 777-2197 FAX

SOUTHERN REGION
13022 8th Street
Bowie, MD 20719
(301) 464-3065
(301) 464-0462 FAX

CENTRAL REGION
2 S. Bond Street
Bel Air, MD 21014
(410) 836-4551
(410) 836-4552 FAX

EASTERN REGION
201 Baptist Street, Suite 22
Salisbury, MD 21801
(410) 543-6745
(410) 543-6768 FAX

COUNTY OFFICES

ALLEGANY
3 Pershing Street, Room 101
Cumberland, MD 21502
(301) 777-2027
(301) 777-2197 FAX

ANNE ARUNDEL
Forestry Education Center
8023 Long Hill Road
Pasadena, MD 21122
(410) 768-0830
(410) 768-7134 FAX

BALTIMORE
Cub Hill Ranger Station
9405 Old Harford Road
Baltimore, MD 21234
(410) 665-5820
(410) 882-9961 FAX

CALVERT
Post Office Box 1136
Prince Frederick, MD 20678
(410) 535-1303
(410) 535-4737 FAX

CAROLINE/TALBOT
Martinak State Park
105 Deep Shore Road
Denton, MD 21629
(410) 479-1623
(410) 822-1800
(410) 479-1814 FAX

CARROLL
328a E. Nicodemus Road
Westminster, MD 21157
(410) 848-3291
(410) 848-9450
(410) 848-3291 FAX

CECIL
Black Hill Ranger Station
130 McKinneytown Road
North East, MD 21901
(410) 287-5777
(410) 287-0010 FAX

CHARLES
P.O. Box 2746
La Plata, MD 20646
(301) 934-2543
(301) 934-8685 FAX

DORCHESTER
4329 Golden Hill Road
Church Creek, MD 21622
(410) 228-1861
(410) 228-6071 FAX

FREDERICK
8602 Gambrill Road
Frederick, MD 21701
(301) 473-8417
(301) 473-4570
(301) 473-8577 FAX

GARRETT
1728 Kings Run Road
Oakland, MD 21550
(301) 334-3296
(301) 334-2737

HARFORD
2 S. Bond Street
Bel Air, MD 21014
(410) 836-4551
(410) 836-4552 FAX

HOWARD/MONTGOMERY
17400 Annapolis Rock Road
Woodbine, MD 21797
(301) 854-6060
(410) 442-2080
(410) 442-2126 FAX

KENT/QUEEN ANNE'S
120 Broadway Avenue
Centreville, MD 21617
(410) 758-5254
(410) 758-5018 FAX

PRINCE GEORGE'S
Huntington Community Center
13022 8th Street
Bowie, MD 20720
(301) 464-3065
(301) 464-0462 FAX

ST. MARY'S
Carter Building
Leonardtown, MD 20650
(301) 475-8551
(301) 475-4036 FAX

SOMERSET
10990 Market Lane
Princess Anne, MD 21853
(410) 651-2004
(410) 651-0397 FAX

WASHINGTON
14038 Blairs Valley Road
Clear Spring, MD 21722
(301) 791-4733
(301) 842-0072 FAX

WICOMICO
Powellville Work Center
6095 Sixty Foot Road
Parsonsburg, MD 21849
(410) 543-1950
(410) 543-2888 FAX

WORCESTER
Nassawango Work Ctr
6572 Snow Hill Road
Snow Hill, MD 21863
(410) 749-2206
(410) 749-0628 FAX

Forestry Boards

ALLEGANY
729 Illinois Street
Cumberland, MD 21502
(301) 729-1109

ANNE ARUNDEL
915 Harwood Road
Harwood, MD 20776
(301) 261-7527

BALTIMORE
7636 Donny Terrace
Kingsville, MD 21087
(410) 592-2400

BALTIMORE CITY
4 Drew Court
Baldwin, MD 21013
(410) 396-0352

CALVERT
3016 Abington Manor Drive
Huntingtown, MD 20639
(410) 535-6813

CAROLINE
10161 River Landing Road
Denton, MD 21629
(410) 479-2827

CARROLL
4036 Schalk Road, #2
Millers, MD 21107
(410) 833-4700

CECIL
100 Mill Lane
North East, MD 21901
(410) 287-5801

CHARLES
P.O. Box 1925
La Plata, MD 20646
(301) 934-1020

DORCHESTER
2104 Wingate-Bishops Head Rd.
Wingate, MD 21675
(410) 397-8909

FREDERICK
12213 Wildcat Road
Myersville, MD 21773
(301) 293-2697

GARRETT
61 Paradise Heights
Oakland, MD 21550
(301) 334-6950

HARFORD
705 Estates Court
Bel Air, MD 21015
(410) 597-7943

HOWARD
5009 Worthington Way
Ellicott City, MD 21043
(410) 465-0654

KENT
210 Manor Avenue
Chestertown, MD 21620
(410) 778-1157

MONTGOMERY
9501 Bruce Drive
Silver Spring, MD 20901
(301) 585-8818

PRINCE GEORGE'S
David Bourdon
SCS Co. Adm. Bldg, Rm 1101
Upper Marlboro, MD 20772
(301) 574-5162

QUEEN ANNE'S
201 Dogwood Lodge Lane
Crumpton, MD 21629
(410) 758-3676

ST. MARY'S
321-B Callahan Drive
Great Mills, MD 20634
(301) 862-5535

SOMERSET
32203 Hess Road
Marion, MD 21838
(410) 957-3411

TALBOT
11550 Plugge Road
Cordova, MD 21625
(410) 822-5476

WASHINGTON
3138 Kaetzel Road
Gapland, MD 21736
(301) 432-6582

WICOMICO
9045 Riggin Road
Mardela Springs, MD 21837
(410) 749-5951

WORCESTER
P.O. Box 156
Berlin, MD 21811
(410) 641-2200

Soil Conservation District Offices

ALLEGANY
11602 Bedford Road, NE
Cumberland, MD 21502
(301) 777-1747 Ext. 4

ANNE ARUNDEL
2662 Riva Road, Suite 150
Annapolis, MD 21401
(410) 222-7822

BALTIMORE
9831 Van Buren Lane
Cockeysville, MD 21030
(410) 666-1188 Ext. 3

CALVERT
65 Duke Street, P.O. Box 657
Prince Frederick, MD 20678
(410) 535-1521 Ext. 3

CAROLINE
640 Legion Road, Suite 3
Denton, MD 21629
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CARROLL
1004 Littlestown Pike, Suite B-2
Westminster, MD 21157
(410) 848-6696

CECIL
Upper Chesapeake Corp Ctr.
101 Chesapeake Blvd, Suite A-3
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CHARLES
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501 Court Lane, Room 213
Cambridge, MD 21613
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FREDERICK
92 Thomas Johnson Drive
Suite 230 North Amber
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1916 Maryland Highway, Suite C
Mountain Lake Park, MD 21550
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1208 Churchville Road, Suite 201
Bel Air, MD 21014
(410) 838-6181 Ext. 3

HOWARD
9025 Chevrolet Drive, Suite J
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(410) 465-3180

KENT
122 Speer Road, Suite 4
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(410) 778-5150 Ext. 3

MONTGOMERY
18410 Muncaster Road
Derwood, MD 20855
(301) 590-2855

PRINCE GEORGE'S
14741 Governor Oden Bowie Drive
Upper Marlboro, MD 20772
(301) 574-5162 Ext. 2

QUEEN ANNE'S
505 Railroad Avenue, Suite 3
Centreville, MD 21617
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ST. MARY'S
22660 Washington Street
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30730 Park Drive
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(410) 651-0390/1575 Ext. 3

TALBOT
215 Bay Street
Easton, MD 21601
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1260 Maryland Avenue, Suite 101
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(301) 797-6821/6820

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2322 B Goddard Parkway
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(410) 546-4777 Ext. 3

WORCESTER
304 Commerce Street
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Glen Burnie, MD 21061
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BALTIMORE CITY
17 S. Gay Street
Baltimore, MD 21202
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BALTIMORE
9811 Van Buren Lane
Cockeysville, MD 21030
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CALVERT
County Services Plaza
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CAROLINE
207 South Third Street
Denton, MD 21629
(410) 479-4030

CARROLL
700 Agriculture Center
Westminster, MD 21157
(410) 386-2760

CECIL
Cecil County Court House
129 E. Main Street, Room 7
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(410) 996-5280

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DORCHESTER
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Cambridge, MD 21613
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(301) 694-1594

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1916 Maryland Highway, Suite A
Mt. Lake Park, MD 21550
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HARFORD
P.O. Box 663
2335 Rock Spring Road
Forest Hill, MD 21050
(410) 638-3255

HOWARD
3525-L Ellicott Mills Drive
Ellicott City, MD 21043
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KENT
Kent County Public Works Complex
709 Morgnec Road, Suite 202
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(410) 778-1661

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18410 Muncaster Road
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30730 Park Drive
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TALBOT
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Easton, MD 21601
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WASHINGTON
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Hagerstown, MD 21740
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Salisbury, MD 21802
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WORCESTER
P.O. Box 219
Snow Hill, MD 21863
(410) 632-1972

NATIVE PLANTS

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns; Uses
DECIDUOUS TREES					
Acer rubrum Red Maple	C/P/M	Sun to partial sun; wet to dry; tolerates flooding, drought, and compaction	Haze of small red flowers early spring; yellow to red fall color varies; new twigs reddish	High: seeds, sap; SB, M	Acid Soils; children play with winged samara
Acer succharum Sugar Maple	M	Sun to partial sun; Moist to well drained	Yellow, orange, and red fall color on same tree	Medium to high; seeds, sap; SB, GB M	Lawn tree, tap for maple syrup, wood used for furniture
Betula nigra River Birch	C/P/M	Sun to partial sun; wet to well drained, tolerates flooding	Fine textured pendulous branches; exfoliating bark reddish brown; yellow fall color	High: fruit; sap; cavity nesting; SB, GB, M	Fast growing; prefers acid soil; wood used for furniture
Fraxinus americana White Ash	P/M	Sun to partial sun; moist to well drained, tolerates drought and compaction	Dark green leaves; yellow to maroon fall color; attractive bark	Low: seed, foliage; SB, M	Wood used for baseball bats
Liquidambar styraciflua Sweetgum	C/P	Sun to part sun; moist to well drained, tolerates compaction	Yellow, orange, red, and/or maroon fall color	Low: seeds; M	Fast growing; large seed capsules can be messy but used for play
Quercus palustris Pin Oak	C/P	Sun; wet to well drained, tolerates flooding and drought	Red fall color, bronze leaves persist in winter; lower branches droop to ground	High: acorns, twigs; SB, GB, M	Acid soil
Quercus phellos Willow Oak	C/P	Sun; wet to well drained, tolerates flooding	Fine textured branches; willow-like leaves	High: acorns; twigs; SB, GB, M	Leaves drop continuously for 6 weeks
Quercus prinus Chestnut Oak	P/M	Sun to partial sun; well drained to dry, tolerates drought	Leaves like American Chestnut; amber fall color	High: acorns, twigs; SB, GB, M	Low heavy horizontal branches, good for swings or climbing
Quercus rubra Red Oak	P/M	Sun to partial sun; well drained	Red fall color	High: acorns, twigs; SB, GB, M, BF	
Salix nigra Black Willow	P/M	Sun to partial sun; wet to moist, tolerates flooding	Haze of yellow-green flowers early spring; pale foliage	Medium: twigs, foliage, nesting; SB GB, M	Fast growing, may be messy; wood used for charcoal
Tilia americana American Linden, Basswood	P/M	Sun to shade; moist to well drained	Dark green foliage	Low: nut like fruit, pollen	Needs large space, bees make honey from it

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns ; Uses
EVERGREEN TREES					
Ilex opaca American Holly	C/P	Sun to partial shade; moist to well drained	Dark leathery leaves; persistent red berries on female plants	High: berries, sap; nesting; SB, GB, BF	Prefers rich moist acid soil, need male and female plants for fruit; susceptible to leaf mino r
Juniperus virginiana Eastern Red Cedar	C/P	Sun; well drained to dry, tolerates drought	Narrow from sometimes irregular dark dense foliage; blue berries; shredding reddish brown black	High: berries; SB, GB, BF, M	Tolerates alkaline soil, short lived, don't plant near apple trees; used for pencils, cedar chests; moth repellant, gin
Pinus strobus Eastern White Pine	M	Sun to partial shade; moist to dry	Loose open habit; long soft fragrant bluish-green needles	Moderate to high: seeds, sap; SB, GB, M	Not tolerant of pollution, prefers acid soils
Pinus taeda Loblolly Pine	C	Full sun; wet to moist tolerates drought	Loose open habit; long stiff yellow-green needles; not ornamental	Moderate: seeds, sap; nesting; SB, M	Fast growing, prefers acid soil
UNDERSTORY TREES					
Amelanchier arborea Shadblow, Serviceberry, Juneberry	P/M	Partial sun to shade; moist to dry	Small produse white flowers in early spring; smooth grey bark; dry red to purple fruit	High: berries, twigs; nesting, cover; SB, M	Available in single trunk or multi-stemmed, prefers acid soil
Carpinus caroliniana Hornbeam, Ironweed Blue Beech	C/P/M	Partial shade to shade, wet to well drained; tolerates drought	Smooth light grey bark appears muscled; orange-red fall color	Moderate: seeds, twigs, leaves; SB, GB, M	Slow growing
Cercis canadensis Redbud	C/P/M	Sun to partial shade; moist to dry, tolerates drought	Pinkish-purple flowers along branches; yellow fall color; large heart shaped leaf; legume pod persists into winter	Low: seeds; M	Some disease problems, tolerates alkaline soil
Chionanthus virginicus Fringe Tree	C/P	Sun to partial shade; wet to dry	White flowers in hanging clusters; late spring or early summer	Moderate: berries on female plants; SB, M	Acid soil
Magnolia virginiana Sweetbay Magnolia	C	Partial sun; wet to moist	Large solitary fragrant white flowers; long pink fruit pod; semi-evergreen; thick shiny leaves	Low: seeds; M	Acid soil
Ostrya virginiana Hophornbeam	P/M	Sun to shade; moist to dry, tolerates drought	Yellow fall color, leaves persist in winter	Moderate: nuts; SB, GB, M	Slow growing, may be hard to transplant

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns; Uses
SHRUBS					
Aronia arbutifolia Red Chokeberry	C/P/M	Sun to partial sun; wet to well drained, tolerates flooding	Small white flowers; orange-red fall color; bright red fruit persists in winter	Moderate: fruit; SB, GB, M	6-12' In masses
Cephalanthus occidentalis Buttonbush	C/P/M	Sun to partial sun; wet to moist, tolerates flooding	Round white flowers in early summer	High: leaves; seeds; nectar; cover; SB, GB, M, hummingbirds	6-12' In masses
Clethra alnifolia Sweet Pepperbush	C	Sun to partial sun; wet, tolerates flooding and compaction	White to pinkish flower spikes; dry fruit capsules persist in winter	Moderate: nectar; attracts butterflies, bees, insects	3-8' Prefers acid soil; suitable for specimen or group
Cornus amomum Silky Dogwood	C/P	Sun to shade; wet to well drained, tolerates flooding	Smooth dull red twigs; small sparse whitish flowers	High: berries, twigs; SB, GB, M	6-9' In masses
Cornus racemosa Grey Dogwood	P/M	Sun to shade; wet to dry, tolerates drought	Slender grey twigs; small whitish flowers and fruit with red stems	High: berries, twigs; SB, GB, M	6-9' In masses
Hammamelis virginiana Witchhazel	P/M	Sun to shade; moist to dry	Small yellow fragrant flowers late fall, yellow fall color	seeds, GB, M	12-20' Capsules spit out seeds, once used for dividing rods, witchhazel lotion from bark
Ilex glabra Inkberry	C	Sun to partial sun; wet to moist, tolerates flooding and compaction	Small dark shiny evergreen leaves	High: berries, nectar; SB, M	6-8' Acid soil, poisonous fruit; use for hedges, groups, masses
Ilex verticillata Winterberry	C/P/M	Sun to partial sun; wet to moist, tolerates flooding	Bright red persistent berries on female plant; grey twigs	High: berries and cover; SB, M, BF	6-8' Need male and female plant, poisonous fruit; slow growing; beautiful in winter, specimen or group
Lindera benzoin Spicebush	C/P/M	Sun to shade; moist to dry, tolerates flooding	Small clusters of yellow flowers early spring; fragrant leaves and twigs; red berries; yellow fall color	High: berries on female plant; SB, GB M, BF	6-12' Prefers acid soil
Myrica pensylvanica Northern Bayberry	C	Sun to partial sun; wet to dry, tolerates flooding, drought and compaction	Small waxy blue-grey berries; all parts aromatic when crushed; light grey twigs	High: berries, cover, nesting; SB, GB, M	5-12' Acid soil; needs and female for good fruit; berries used to make candles
Myrica cerifera Southern Bayberry	C	Sun to partial sun; wet to dry, tolerates flooding, drought and compaction	Evergreen; waxy bluish-white berries, aromatic leaves	High: berries, cover, nesting; SB, GB, M	9-15' Acid soil; needs male and female for good fruit

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns ; Uses
Rhus copallina Shining Sumac, Flameleaf Sumac	C/P/M	Sun; dry, tolerates drought	Yellowish-green flower spike; hairy red berries on female plant; glossy leaves, bright red fall color	High: berries; SB, GB, M	20-30' Compact when young but fast growing
Rhus glabra Smooth Sumac	C/P/M	Sun; dry, tolerates drought and compaction	Yellowish-green flower spike; hairy red fruit on female plant; bright red fall color	High: berries; SB, GB, M	9-15' Fast growing; good on slopes
Vaccinium corymbosum Highbush Blueberry	C/M	Sun to partial sun; wet to dry, tolerates flooding	Clusters of white flowers in late spring; profuse edible blue berries, dark green foliage; red fall color	High: berries; SB, GB, M	6-9' Requires acid soil
Viburnum dentatum Arrowwood	C/P/M	Sun to partial sun; wet to dry, tolerant of flooding and drought	White flower clusters; blue-black fruit; red fall color may vary	Medium to high: berries; SB, GB, M	6-10' Wood used to make arrows by Native Americans, suckers freely in wet soils
Viburnum prunifolium Blackhaw	C/P/M	Sun to partial sun; wet to dry	White flower clusters; black fruit; red fall color	Medium to high: berries; SB, GB, M, butterflies	12-15' Hawthorn like habit, tolerates alkaline soil, edible fruit
Viburnum trilobum American Cranberry Bush	M	Sun to partial sun; moist to dry	White flower clusters; red berries, yellow to red fall color; gray twigs	Medium to high: berries; SB, GB, M	8-12' Can make jam from edible berries
Viburnum lentago Nannyberry	M	Sun to shade; moist to dry	Creamy white flower cluster; mottled fall color; berries change color red to black	Medium to high: berries; SB, GB, M butterflies	20' Often suckers, tolerates alkaline soil

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

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